A HUMAN GEOGRAPHY OF THE BRITISH ISLES

BY

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A HUMAN GEOGRAPHY OF THE BRITISH ISLES.

CHAPTER I.

CLIMATE AND WEATHER.

CLIMATE.

THE average conditions of wind, rainfall, dampness, and temperature.

WEATHER.

The actual conditions of temperature, wind, and rainfall experienced.

The general conditions affecting the climate of a region are (1) its latitude, (2) its nearness to the sea, (3) the ocean currents which wash its shores, (4) the winds which cross it, (5) the position of its mountains, (6) the height of the region above sea-level, and (7) the nature and slope of its surface.

(1.) **Latitude.**—Generally speaking, the nearer one gets to the poles the colder the temperature becomes. The reasons for this are that nearer the poles: (*a*) The sun's rays strike the earth obliquely, and have to heat and light a much greater area than is the case with the rays reaching the earth near the equator. (*b*) To a much less extent the sun's rays have to pass through a thicker layer of air, and consequently lose more heat before reaching the earth, than is the case at the equator.

For our purpose we shall divide the earth into *four zones of temperature*—the cold, the cool, the warm, the hot.

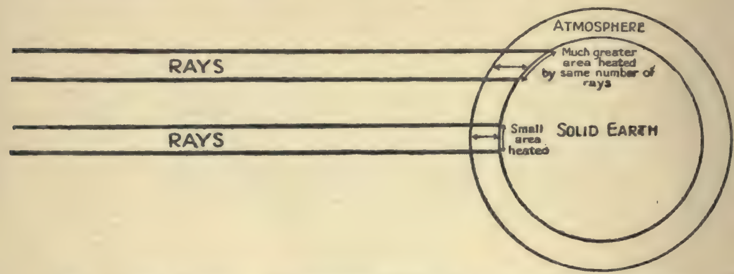


FIG. 1. (Not to scale.)—Illustrating why the Equator is the warmest part of the Earth's surface.

The **British Isles** are situated to the north of the cool zone in the northern hemisphere.

(2.) **Nearness to the Sea.**—If the surface of the earth was entirely composed of land or of water, each zone in Fig. 2 would be of uniform temperature—the whole zone being warmer in summer and cooler in winter. This, however, is not the case, land and sea being found in every zone. As water absorbs

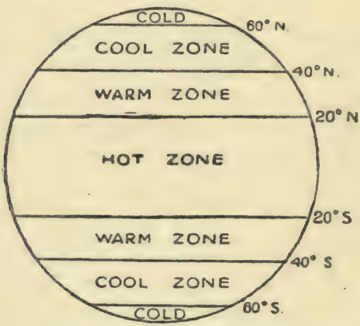


FIG. 2.—Zones of Temperature.

and loses heat more slowly than the land, places near the sea are cooler in summer and warmer in winter than places inland

in the same latitude. The **British Isles** are in the sea, and as a result are cooler in summer and warmer in winter than places situated in the interior of the continents of **Europe, Asia,** and **America** of the same latitude.

If we take the average temperature for the coldest month of the year—January—we find that the British Isles have a temperature of about 40° F., while Central Russia in the same latitude has a temperature of about 20° F.

If we take the month of July, the averages are for the British Isles about 60° F., and for Central Russia about 70° F. Thus the average annual range of temperature in the British Isles is about 20° F., while that of Central Russia is from 40° to 50° F. This is what is meant by saying that the British Isles have an "equable climate," Central Russia an "extreme climate."

. In the atlas we find isothermal maps. **Isotherms** are lines joining places which have the same temperature.

In Fig. 3 is a map of Europe showing a summer (60° F.) and a winter (40° F.) isotherm. From it we see that the interior of Europe in the latitude of 54° N. is much cooler than the British Isles in winter and much warmer in summer.

(3.) **Ocean Currents.**—Where ocean currents are composed of warm water they warm the coasts they wash. The British Isles are in the course of the warm waters which are blown from the **Gulf Stream** across the Atlantic, whereas countries such as Labrador and North-east Asia, though in the same latitude as the British Isles, are washed by cold currents. Consequently the western coasts are much warmer, particularly in winter, than the east coasts of the northern continents.

(4.) **Winds.**—Winds blowing from a warm sea bring both moisture and warmth. The winds which blow most frequently over these islands are from the west and south-west. They bring rain and warmth. In our latitudes the winds do not blow steadily from one direction for any length of time, but cross the country in great eddies, so that as a storm rises the wind may be blowing from the south-west in London, south

FIG. 3.—Typical Isotherms for Europe.

in East Anglia, and south-east and east in Scotland. These eddies are called **cyclones**, and generally cross the land from west to east or south-west to north-east, or north-west to south-east.

(5.) **Position of Mountains.**—In the British Isles the mountains are on the west. The mountains cause the winds coming from the west to drop the moisture they have absorbed from the Atlantic in the form of rain. Examine a rainfall

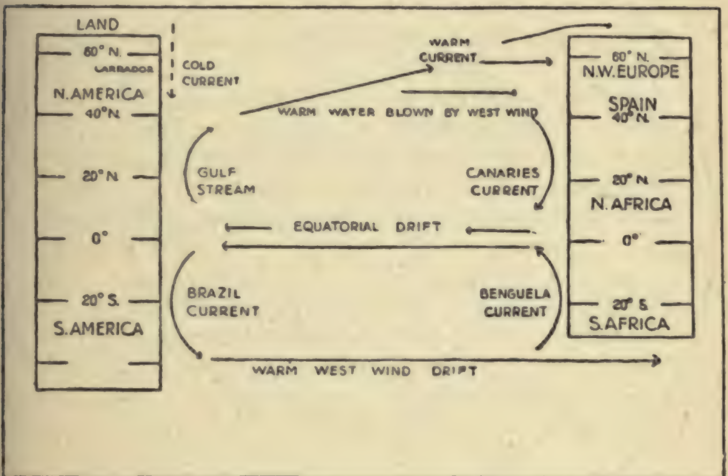


FIG. 4.—**Plan of the Currents of the Atlantic Ocean.**

map of the British Isles, and you will find that the rainfall is heaviest where there are high hills and mountains. You will also notice that the west coast is much wetter than the east coast. The western mountains rob the westerly winds of the bulk of their moisture, so that there is much less rain left to fall on the eastern parts of the country.

(6.) **Height above Sea-level.**—It is found that the higher one goes up a mountain the colder it becomes. Fortunately we have no really high mountains, so that there is no part

of the islands where it is extremely cold. Nevertheless, there are many desolate regions in the hilly parts where for a considerable part of the year snow lies unmelted.

(7.) **Slope.**—In places where the land slopes towards the

Fig. 5.—Diagram of the prevailing winds, showing approximately the relation of British winds to those of the world.

equator the climate is generally milder than in those which slope towards the poles. Again, we are fortunate in the fact that the British Isles do not slope towards the poles, but are almost level.

The Effect of Climate on Human Energy.

Light.—The excess of light in the tropics is at first beneficial, but in time men become nervous and irritable and feel lazy. On cloudy days more work can be done than on bright days.

Temperature.—Generally speaking, cold is more beneficial than heat. Temperatures above 85° F. are harmful to the white man, who does his best work at a temperature of about 40° F. The variations, both in the yearly and the daily temperatures, make Britain the place where people feel more energetic than anywhere else in the world. The ideal climate for human life is one with a range of temperature between 38° F., where mental energy is at a maximum, and 65° F., where maximum physical efficiency is enjoyed. London has a January mean temperature of 38° F. and a July mean of 63° F.

Height above Sea-level.—When a person climbs a mountain the number of red corpuscles in the body increases, making it possible for the lungs to absorb more oxygen on returning to the valley. It was perhaps in this manner that the Highlanders became such a hardy race.

Humidity.—A certain amount of moisture in the atmosphere is necessary for human beings. A large number of the "colds" of winter are caused by people keeping the living rooms of their houses too dry during the winter months.

Wind.—Short-lived gales and frequent light winds are beneficial, while calms and prolonged gales are harmful. People work harder at the end of a storm. We see that regions of cyclonic storms are good for promoting human activity. They promote vigour and mental development. The result is that the British Isles, the Great Lakes and New England regions of North America, Scandinavia, the coasts of France, Germany, South Argentine, New Zealand, and Japan are the best lands for the development of human civilization. The extremes of the continental U.S.A. and Germany give to their inhabitants a nervous tension which contrasts with the stolid

temperament of the British, Dutch, Japanese, and people of Eastern U.S.A.

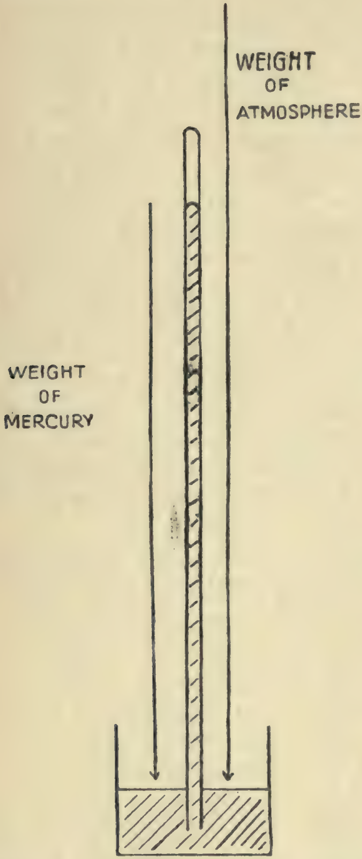


Fig. 6.—The Barometer. The pressure of the mercury in the tube is balanced by the pressure of the atmosphere.

Weather Measurements.

The instruments used in weather science are the **barometer**, the **rain gauge**, and **the thermometer.**

(1.) The Barometer.

Why does not the mercury in the barometer empty itself into the trough at the bottom?—The reason is that the weight of the air above balances the weight of the mercury in the tube.

Thus, when the height of the mercury in the barometer tube alters it is a sign that the weight of the air above is altering. If the mercury falls we know that the air above is getting less dense—that is, it is expanding. When air expands it cools, and the cooling causes the moisture in the air to condense as rain. Thus when the mercury falls it shows that there is a tendency for rain to fall. It is possible to measure the height of mountains roughly by means of the barometer, because at the mountain top there is a much less weight of

air above. It is found that at sea-level the weight of an air column of 9 feet in depth is equal to the weight of $\frac{1}{100}$ inch of mercury of the same cross section.

The approximate height of a hill can be found by multiplying the difference in hundredths of an inch mercury pressure between the bottom and the top of the hill by 9. For example, a steep hill rises from sea-level. The reading of the barometer at the bottom of the hill is 29.00 inches of mercury, while the reading at the summit is 28.30 inches. The difference in the readings is .70 inch. Therefore the height of the hill is about 630 feet.

Formerly pressure was recorded in inches of mercury, and on the Continent in millimetres. Neither the millimetre nor the inch of mercury has any direct relation to the scientific units of the C.G.S. system ; so in order to bring weather science into line with scientific measurement generally, and also to make international observations possible, a new unit of barometric pressure was adopted—the **bar**, or C.G.S. atmosphere. The C.G.S. unit of force is the **dyne** (equals the weight of .00102 grams). One thousand dynes per square centimetre equals 1 **millibar** (.0295 inch of mercury). One thousand millibars is called a **bar**, or atmosphere, and is equal to the average pressure at 106 metres above sea-level in latitude 45° (29.53 inches and 750.1 mm.). All pressures used in weather forecasting are now recorded in millibars.

The Aneroid Barometer.—The aneroid barometer consists of a partially evacuated metal box, the expansion and contraction of which with changes of pressure works an arm which moves over a scale graduated to show barometric pressures. If a self-recording arrangement is added the instrument is called a **barograph**, and changes of pressure show themselves as they occur. Aneroid barometers can be used accurately even when they weigh less than a quarter of an ounce, as in the Dines instrument for measuring upper air temperatures and pressures (**meteorographs**).

METHODS OF COMPUTING HEIGHTS FROM PRESSURES.

(1.) **Laplace's Formula.**—Let P_0 be the pressure at sea-level, and P the pressure at the height which is to be found. Let H be the height to be found.

Then $H = .06740T (\log_{10} P_0 - \log_{10} P)$ where T is the absolute temperature of the air column between the place and sea-level. Since $\log P_0 - \log P = \log \frac{P_0}{P}$, the units of pressure may be disregarded whether they are millibars, millimetres, or inches. To get T obtain the harmonic mean:
$\frac{m}{T} = \frac{1}{T_0} + \frac{1}{T_1} + \frac{1}{T_2} \ldots\ldots\ldots\ldots, + \frac{1}{T(m-1)}$.

(2.) **The Graphical Method** of getting heights is the easiest. The graph of the equation $H = KT \log \frac{P_0}{P}$ is a straight line.

(3.) **The Barometric Formula.**—Let P be the pressure at the height H, D the density, g the value of gravity. Then

(i.) $dP = -gD.dH$ where $D = \frac{1}{R} \cdot \frac{P}{T}$ where R is a constant.

(ii.) $\frac{dP}{P} = \frac{-g.dH}{RT}$.

(iii.) $d(\log_e P) = \frac{-g.dH}{RT}$.

(iv.) $d(\log_{10} P) = \frac{-g}{R} \cdot \log_e. \frac{dH}{T}$

Using decametre, tonne, second, in latitude 45°, $g = .980617$; $\frac{1}{R} = .348394$; $\log_{10} e = .43429$.

Then $d \log P = -.14837 \frac{dH}{T}$.

Using kilometres, $d \log P = -14.837 \frac{dH}{T}$.

Where T is constant (isothermal atmosphere), the integral is

$$\log P_0 - \log P = 14.837 \frac{H}{T}.$$

Where H is the interval in kilometres,

$$\log \frac{P_0}{P} = 14.837 \frac{H}{T}.$$

In general T is dependent on height and the integral $\int \frac{dH}{T}$ has to be evaluated.

(4.) **Approximate Formula without Logs.**

$$P_0 = \frac{P_0 + P}{2} + \frac{P_0 - P}{2}.$$

$$H = 29.3 \frac{(P_0 - P)(T_0 + T)}{(P_0 + P)} \text{ metres.}$$

(5.) **Babinet's Formula.**

$$H = 32 \frac{(P_0 - P)(T_0 + T - 46)}{(P_0 + P)} \text{ metres.}$$

These formulæ refer to dry air.

Allowance can be made for (*a*) **Humidity.** Then

$$d \log P = -.014837\left(1 - \frac{3e}{8P}\right)\frac{dH}{T},$$

where e is the parial pressure of water vapour. In cold air the factor $\left(1 - \frac{3e}{8P}\right)$ is very nearly one. In warm damp air it may be nearly .99. (*b*) **Gravity.** If latitude=L, E the radius of the earth, and k=.00259, then
$d \log P = -.014837\ (1 - k \cos 2L)\left(1 - \frac{\pi H}{10^7}\right)\frac{dH}{T}$

Reduction of Barometric Readings.

CORRECTION OF READINGS FOR HEIGHT ABOVE SEA-LEVEL H, TEMPERATURE T IN DEGREES FAHRENHEIT, AND LATITUDE L.

(1.) *To the freezing point of Water.* The correction

$$= \frac{.0000908\ (t-32) + .000306}{1 + .0001010\ (t-32)}. \text{ H in British units.}$$

(2.) *For Latitude* 51° the height difference = −16.4 feet.
54° " " = −26.25 "
55° " " = −29.53 "

(3.) *To Sea-level.*

$$\log \frac{P_0}{P} = \frac{H.R\ (1 - .00259 \cos 2L)(d \log_{10} e)(P + P_0 - .75\phi)}{(R+H)(D.P_n)(1 + a\theta)(P + P_0)},$$

where H is the height above sea-level, L the latitude, d the density of air at freezing point in latitude 45°, P_n the normal barometric pressure 1,013 millibars, ϕ the mean pressure of water vapour in the air column, R the radius of the earth, D the density of mercury at freezing point, a the coefficient of expansion of air, θ the mean temperature between the station and sea-level.

From this formula tables have been prepared (see the *Computer's Handbook*, published by the Meteorological Office), *e.g.* :

(1.) For a pressure of 1,000 mbs. at a station 230 feet above sea-level—

Temperature	9° F.	27° F.	45° F.	63° F.	81° F.	99° F.
+Correction mbs.	8.98	8.64	8.33	8.04	7.77	7.52
(2.) Pressure 950 mbs. at 230′	8.8	8.5	8.2	7.9	7.6	7.4
" " 330′	12.6	12.2	11.7	11.3	10.9	10.5
(3.) Pressure 1,050 mbs. at 230′	9.8	9.3	9.0	8.7	8.4	8.2
" " 330′	14.0	13.4	12.9	12.5	12.1	11.7

(4.) In inches at 325′—

Temperature.	20° F.	30° F.	40° F.	50° F.	60° F.	70° F.	80° F.
Pressure 28″ (948.2 mbs.) .	·355″	·337″	·332″	·329″	·326″	·309″	·303″
„ 29″ (982.0 mbs.) .	·367″	·359″	·351″	·343″	·337″	·330″	·323″
„ 30″ (1,015.9 mbs.).	·380″	·371″	·363″	·356″	·348″	·341″	·334″
„ 31″ (1,050.0 mbs.).	·393″	·384″	·375″	·363″	·359″	·352″	·345″

We see that an absolutely correct barometer reading is difficult to obtain.

Summary of Corrections of Barometric Readings.

(1.) For incorrect graduation-*index error.*
(2.) For reduction to freezing point.
(3.) For the variation of gravity.
(4.) For height above sea-level.

Thus, when the results are telegraphed the barometer readings are for the same height, temperature, etc., and can be used for purposes of comparison. This makes it possible to forecast the weather, though without the careful reduction the readings are not of much value.

(2.) The Rain Gauge.

The rainfall is the depth of rain which falls. To measure this we use an instrument called a rain gauge. This consists of a circular funnel on which the rain falls. The water enters the funnel and falls into the receiving vessel below. The volume of water found in the receiving vessel is measured daily. This volume is divided by the area of the mouth of the funnel on which the rain falls. This gives the depth of rain which has fallen during the day.

Let us suppose that the volume of water measured is 52 c.c., and that the area of the top of the funnel is πr^2, where r is the radius of the circular funnel into which the rain falls. Suppose the diameter of the funnel is 12 cm., the radius will be 6 cm., and the area on which the rain falls will be 113.04 sq. cm.

$$\text{Then the rainfall for that day} = \frac{\text{Volume (V)}}{\text{Area (A)}}.$$

$$= \frac{52 \text{ c.c.}}{113.09} \text{ sq. cm.}$$

$$= .46 \text{ cm.}$$

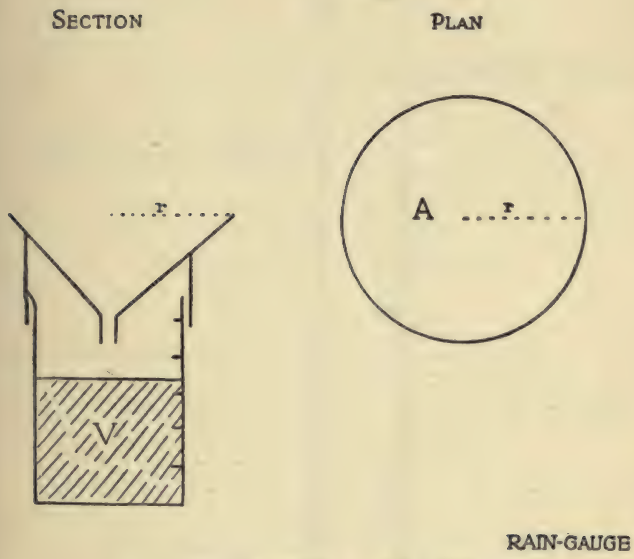


FIG. 7.—Diagram of Rain Gauge.

(3.) The Thermometer.

Ordinary Fahrenheit thermometers are used in weather measurements. When thermometers are self-registering they are called **Thermographs.**

Saturation.

When air contains as much moisture as it can ordinarily contain it is said to be saturated. If it contains more it is said to be super-saturated, and rain falls until the air is merely

saturated. Cold air can contain less moisture than warm air. Therefore, if air is cooled until moisture is deposited, the

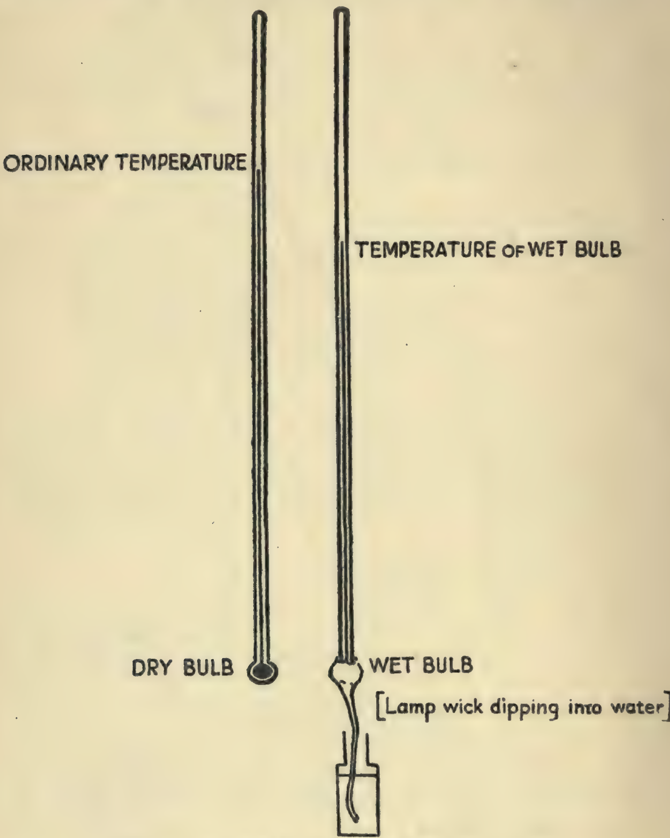


FIG. 8.—The Wet and Dry Bulb Thermometers.

temperature is reached at which the air is saturated. This is called the **saturation temperature** or **dew point.**

If two thermometers are taken, and the bulb of one is kept moist by means of a moist cloth (lamp wick), while the

other is exposed to the air, an instrument is made which shows whether moisture is likely to be deposited. The air which reaches the wet bulb will be damp, and evaporation will take place from the wet bulb, reducing the temperature. Therefore, if the same temperature is recorded by both thermometers, the ordinary air will also be saturated, and there will be a tendency for rain, fog, or cloud to form near the thermometers. If, on the other hand, the ordinary temperature is much higher than that of the wet bulb, the air will be relatively dry, and moisture will not in all probability be deposited. Thus the wet and dry bulbs give some indication of the kind of weather coming, so that if the dry bulb temperature approaches that of the wet bulb, and at the same time the height of mercury in the barometer falls, it is an indication that there is a change in the weather conditions.

Relative Humidity.

The relative humidity is the ratio between the amount of moisture actually present in the air and the amount the air can contain when saturated. The following tables give the relative humidities for different temperatures :—

DRY BULB, WET BULB, AND RELATIVE HUMIDITY.

Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.
Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.
26	26.0	100		26.8	95		27.6	91		28.4	89
	25.8	95		26.6	91		27.4	87		28.2	86
	25.6	90		26.4	87		27.2	84		28.0	82
	25.4	85		26.2	83		27.0	80		27.8	79
	25.2	80		26.0	79		26.8	76		27.6	76
	25.0	76		25.8	75		26.6	73		27.4	73
	24.8	72		25.6	71		26.4	70		27.2	70
	24.6	68		25.4	68		26.2	67		27.0	67
	24.4	64		25.2	64		26.0	64		26.8	64
	24.2	61		25.0	61		25.8	61		26.6	61
	24.0	58		24.8	58		25.6	58		26.4	58
	23.8	55		24.6	55		25.4	55		26.2	56
	23.6	52		24.4	52		25.2	53	30	30.0	100
	23.4	49		24.2	49	29	29.0	100		29.8	96
	23.2	46	28	28.0	100		28.8	96		29.6	93
27	27.0	100		27.8	95		28.6	93		29.4	90

DRY BULB, WET BULB, AND RELATIVE HUMIDITY—(*Continued*).

Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.
Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.
	29.2	86		31.2	80		33.0	68		32	43
	29.0	83		31.0	78		32.0	61		31	39
	28.8	80		30.8	76		31.0	55		30	35
	28.6	77		30.6	74		30.0	49		29	31
	28.4	75		30.4	72		29.0	44		28	28
	28.2	72		30.2	71		28.0	39	42	42	100
	28.0	69	34	34.0	100	38	38.0	100		41	92
	27.8	67		33.8	98		37.0	91		40	85
	27.6	64		33.6	96		36.0	83		39	78
	27.4	62		33.4	93		35.0	75		38	72
	27.2	60		33.2	91		34.0	68		37	66
31	31.0	100		33.0	89		33.0	62		36	60
	30.8	96		32.8	87		32.0	56		35	54
	30.6	93		32.6	85		31.0	50		34	49
	30.4	90		32.4	83		30.0	45		33	44
	30.2	87		32.2	81		29.0	41		32	40
	30.0	85		32.0	79		28	37		31	36
	29.8	82		31.8	78	39	39	100		30	33
	29.6	79		31.6	76		38	92		29	30
	29.4	77		31.4	74		37	84		28	27
	29.2	74		31.2	73		36	77	43	43	100
	29.0	72	35	35.0	100		35	70		42	92
	28.8	70		34.8	98		34	63		41	84
	28.6	68		34.6	96		33	57		40	78
	28.4	66		34.4	94		32	52		39	71
	28.2	64		34.2	92		31	47		38	65
32	32.0	100		34.0	90		30	42		37	59
	31.8	97		33.8	88		29	38		36	54
	31.6	94		33.6	86		28	34		35	49
	31.4	92		33.4	84	40	40	100		34	45
	31.2	89		33.2	82		39	92		33	41
	31.0	87		33.0	80		38	84		32	37
	30.8	84		32.8	79		37	76	44	44	100
	30.6	82		32.6	77		36	69		43	92
	30.4	79		32.4	75		35	63		42	84
	30.2	77		32.2	74		34	57		41	77
	30.0	75		32.0	72		33	51		40	71
	29.8	73	36	36.0	100		32	46		39	65
	29.6	71		35.0	91		31	42		38	59
	29.4	69		34.0	82		30	38		37	54
	29.2	67		33.0	74		29	34		36	49
33	33.0	100		32.0	66	41	41	100		35	45
	32.8	97		31.0	59		40	92		34	41
	32.6	95		30.0	53		39	84		33	37
	32.4	93		29.0	47		38	77		32	34
	32.2	91		28.0	42		37	70	45	45	100
	32.0	89	37	37.0	100		36	64		44	92
	31.8	86		36.0	91		35	58		43	85
	31.6	84		35.0	83		34	53		42	78
	31.4	82		34.0	75		33	48		41	72

DRY BULB, WET BULB, AND RELATIVE HUMIDITY—(*Continued*).

Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.
Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.
	40	66		41	53		52	86		50	57
	39	60		40	49		51	80		49	53
	38	55		39	45		50	74		48	49
	37	50	50	50	100		49	69	59	59	100
	36	46		49	93		48	64		58	94
	35	42		48	86		47	59		57	88
	34	38		47	80		46	55		56	82
	33	34		46	74		45	51		55	76
	32	31		45	68		44	47		54	71
46	46	100		44	63	55	55	100		53	66
	45	93		43	58		54	93		52	61
	44	86		42	53		53	87		51	57
	43	79		41	49		52	81		50	53
	42	73		40	45		51	75		49	49
	41	67		39	41		50	70	60	60	100
	40	61	51	51	100		49	65		59	94
	39	56		50	93		48	60		58	88
	38	51		49	86		47	56		57	82
	37	47		48	80		46	52		56	76
	36	43		47	74		45	48		55	71
47	47	100		46	68	56	56	100		54	66
	46	93		45	63		55	93		53	62
	45	86		44	58		54	87		52	58
	44	79		43	54		53	81		51	54
	43	73		42	50		52	75		50	50
	42	67		41	46		51	70	61	61	100
	41	61	52	52	100		50	65		60	94
	40	56		51	93		49	60		59	88
	39	51		50	86		48	56		58	82
	38	47		49	80		47	52		57	77
	37	43		48	74		46	48		56	72
48	48	100		47	69	57	57	100		55	67
	47	93		46	64		56	93		54	62
	46	86		45	59		55	87		53	58
	45	79		44	54		54	81		52	54
	44	73		43	50		53	75		51	50
	43	67		42	46		52	70	62	62	100
	42	62	53	53	100		51	65		61	94
	41	57		52	93		50	61		60	88
	40	52		51	86		49	57		59	82
	39	48		50	80		48	53		58	77
	38	44		49	74		47	49		57	72
49	49	100		48	69	58	58	100		56	67
	48	93		47	64		57	93		55	62
	47	86		46	59		56	87		54	58
	46	79		45	55		55	81		53	54
	45	73		44	51		54	76		52	50
	44	67		43	47		53	71	63	63	100
	43	62	54	54	100		52	66		62	94
	42	57		53	93		51	61		61	88

DRY BULB, WET BULB, AND RELATIVE HUMIDITY—(*Continued*).

Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.
Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.
	60	82		58	56		68	79		66	55
	59	77		57	52		67	74	77	77	100
	58	72	68	68	100		66	69		76	94
	57	67		67	94		65	65		75	89
	56	63		66	88		64	61		74	84
	55	59		65	83		63	57		73	79
	54	55		64	78		62	54		72	75
	53	51		63	73	73	73	100		71	71
64	64	100		62	68		72	94		70	67
	63	94		61	64		71	89		69	63
	62	88		60	60		70	84		68	59
	61	82		59	56		69	79		67	56
	60	77		58	52		68	74	78	78	100
	59	72	69	69	100		67	70		77	94
	58	67		68	94		66	66		76	89
	57	63		67	88		65	62		75	84
	56	59		66	83		64	58		74	79
	55	55		65	78		63	54		73	75
	54	51		64	73	74	74	100		72	71
65	65	100		63	68		73	94		71	67
	64	94		62	64		72	89		70	63
	63	88		61	60		71	84		69	59
	62	83		60	56		70	79		68	56
	61	78		59	53		69	74	79	79	100
	60	73	70	70	100		68	70		78	95
	59	68		69	94		67	66		77	90
	58	63		68	88		66	62		76	85
	57	59		67	83		65	58		75	80
	56	55		66	78		64	55		74	75
	55	51		65	73	75	75	100		73	71
66	66	100		64	69		74	94		72	67
	65	94		63	65		73	89		71	63
	64	88		62	61		72	84		70	59
	63	83		61	57		71	79		69	56
	62	78		60	53		70	74	80	80	100
	61	73	71	71	100		69	70		79	95
	60	68		70	94		68	66		78	90
	59	64		69	88		67	62		77	85
	58	60		68	83		66	58		76	80
	57	56		67	78		65	55		75	75
	56	52		66	73	76	76	100		74	71
67	67	100		65	69		75	94		73	67
	66	94		64	65		74	89		72	63
	65	88		63	61		73	84		71	59
	64	83		62	57		72	79		70	56
	63	78		61	53		71	75	81	81	100
	62	73	72	72	100		70	71		80	95
	61	68		71	94		69	67		79	90
	60	64		70	89		68	63		78	85
	59	60		69	84		67	59		77	80

DRY BULB, WET BULB, AND RELATIVE HUMIDITY—(*Continued*).

Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.	Dry.	Wet.	R. H.
Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.	Deg. F.	Deg. F.	Per Cent.
	76	76		79	80		82	85		86	95
	75	72		78	76		81	80		85	90
	74	68		77	72		80	76		84	85
	73	64		76	68		79	72		83	81
	72	60		75	64		78	68		82	77
	71	56		74	60		77	64		81	73
82	82	100		73	57		76	61		80	69
	81	95	84	84	100		75	58	88	88	100
	80	90		83	95	86	86	100		87	95
	79	85		82	90		85	95		86	90
	78	80		81	85		84	90		85	85
	77	76		80	80		83	85		84	81
	76	72		79	76		82	80		83	77
	75	68		78	72		81	76	89	89	100
	74	64		77	68		80	72		88	95
	73	60		76	64		79	68		87	90
	72	57		75	60		78	64		86	85
83	83	100		74	57		77	61		85	81
	82	95	85	85	100		76	58		84	77
	81	90		84	95	87	87	100		83	73
	80	85		83	90						

Isotherms.

Isotherms are lines joining places of equal temperature. Isothermal maps can be found in an atlas, and show which regions are warm and which cold.

Temperature of the Upper Air.

The instruments which are required for finding the temperatures of the air at different heights are a balloon or aeroplane, and an instrument which the balloon carries which can measure the height and the temperature—the **meteorograph.** The lightest of such instruments, and therefore the one which can be carried to very great heights, is the **Dines meteorograph.** This consists of an aneroid barometer which moves an arm. It also possesses an invar bar which is fixed at one end to a piece of metal, the other end of which is free to contract as the piece of metal cools. The free ends from the

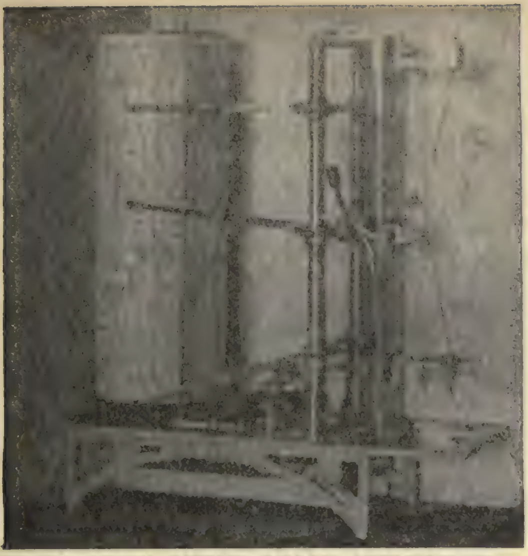
aneroid box and the cooling metal are joined to levers which multiply their movements. The ends of the levers are arranged to scratch a small plate coated with silver. This plate is about as big as a postage stamp.

Calibration of the Dines Meteorograph.

The instrument is subjected to low temperatures and pressures, and by means of an electrical striker a series of dots for different pressures from 950 mbs. to 200 mbs. are made. The instrument is then placed in an aluminium cylinder, which is then fastened to a spider framework of bamboo rods which has red flags fixed to its corners to attract attention ; a label offering 5s. reward to the finder is attached, and the spider, with the cylinder containing the meteorograph, is attached to a balloon, which is then released and ascends to a great height, say 7 to 12 miles, bursts, and falls, the fabric of the balloon, acting as a parachute, preventing damage to the meteorograph. When recovered the meteorograph plate is found to be scratched by the pens at the ends of the levers. The scratches are read through a microscope, and the readings plotted on squared paper. From the readings the temperatures and pressures are obtained. From the pressures the heights are calculated.

Aeroplanes, however, are now able to fly to over 30,000 feet, and can carry heavier and more accurate instruments, such as the **Richard meteorograph,** the **Marvin** (U.S.A.), and the English **barothermographs,** while wet and dry bulb readings are taken up to 16,000 feet, so that except for very great heights aeroplanes are more reliable than balloons.

The following gives the results obtained at Crinan on July 1, 1908 :—



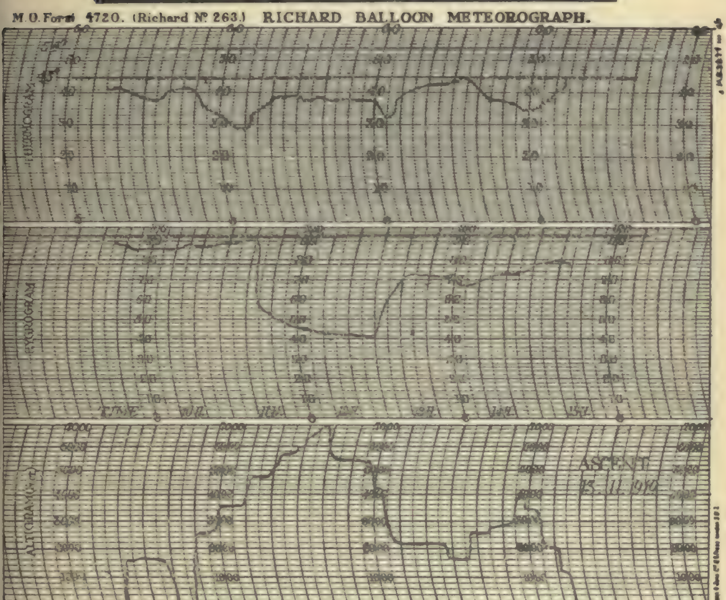


FIG. 9.—The Richard Meteorograph and its trace.

	Heights in Feet.	Temperatures. Deg. F.
Troposphere	0	55
	2,000	52
	4,000	45
	6,000	40
	8,000	33
	10,000	30
	12,000	23
	14,000	18
	16,000	13
	18,000	8
	20,000	2
	22,000	−7
	24,000	−15
	26,000	−20
	28,000	−25
	30,000	−34
	32,000	−40
Stratosphere	34,000	−40
	36,000	−39
	38,000	−38
	40,000	−37
	42,000	−37
	44,000	−36
	46,000	−35
	48,000	−35
	50,000	−37
	52,000	−42
	54,000	−41
	56,000	−42
	58,000	−42
	60,000	−41
	62,000	−41
	64,000	−41
	66,000	−41

Draw the curve for this—heights on the vertical axis and temperatures on the horizontal axis. Notice that between 30,000 and 40,000 feet the temperature no longer falls with increase of height to any extent. This is one of the most remarkable facts obtained from balloon ascents. The atmosphere consists of two parts: (1) The lower part, where the temperature falls at the average rate of 1° F. per 300 feet rise. This part is about 5 to 7 miles in depth, and has received the name **troposphere**; while (2) above this the temperature remains practically constant for changes in height, though its temperature throughout is by no means constant. The **stratosphere,** as it is called, is lowest over the poles and

highest over the equator, where at Victoria Nyanza $-119°$ F. was met with in the stratosphere. When cyclones prevail the stratosphere is lower, and over anticyclones higher and somewhat colder.

Temperature decreases with height more rapidly in cyclones than in anticyclones, because the low temperatures in our clear winter anticyclones are due to the rapid cooling of the surface layers by radiation, so that in winter the air in an anticyclone is relatively warm above the surface layers. This is called an inversion of temperature. Inversions of temperature occur sometimes when the air does not show a cooling of 1° F. per 300 feet. There are layers of air in which the temperature increases with height. These layers are frequently very dry, because they are very probably composed of air which has descended from higher regions in the atmosphere. They are encountered chiefly in anticyclonic conditions.

Adiabatic or Isentropic Condition of the Atmosphere.

Air is said to be adiabatic when heat is not added to it from outside or taken away from it. If a mass of air becomes warmer at the surface of the ground and rises, it can obtain no more heat after it leaves the surface, because the air above is practically non-conducting. It thus becomes almost adiabatic. Because of this, cooling can be the result of heating. The rate of cooling (adiabatically) is 1° F. per 185 feet rise—*i.e.* the rate of cooling due to the expansion of air as it rises. We know that the actual rate of cooling in ordinary air is 1° F. per 300 feet rise. Let air be heated 2° F. It expands and rises. When it reaches 900 feet it has cooled $\frac{900}{185}$ degrees—*i.e.* 5° F.—but the ordinary air cools at the rate of 1° F. per 300 feet rise. Thus the result of heating air 2° F. is that the air has risen 900 feet, and is as cold as the air now surrounding it. If the air which has risen rises farther, it becomes colder than the air surrounding it, and if it is fairly damp large cumulus clouds are formed. Similarly, if air is cooled it will

fall 185 feet for every degree fall in temperature, and will reach the surface of the earth extremely dry.

Tables of the rate of cooling of dry air and average rates

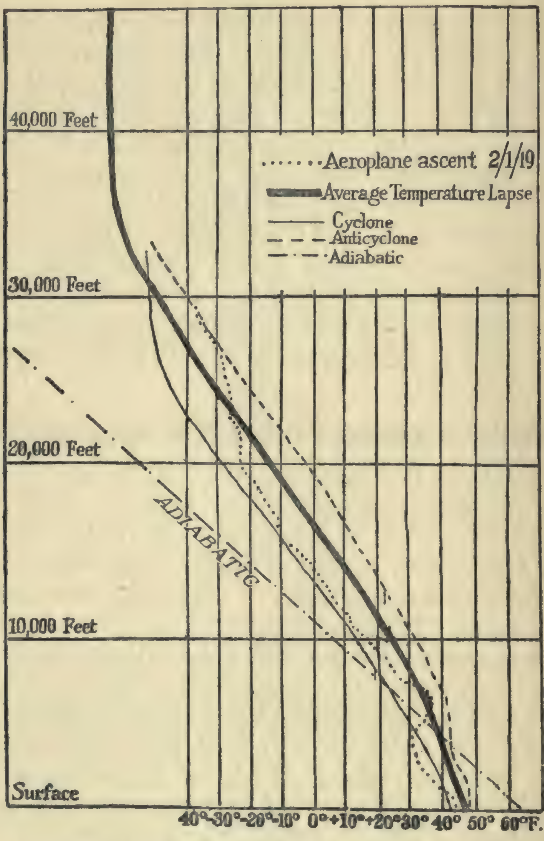


FIG. 10.—Graphs showing rates of cooling with height.

of cooling in cyclones and anticyclones have been made, and from them interesting graphs can be made.

By plotting the upper air temperatures recorded by mete-

orographs and during aeroplane ascents some indications of the coming weather can be obtained.

Forms in which Moisture is Deposited.

Rain.

As a rule rain before falling is held up in the form of clouds. If the air which is supersaturated contains dust, drops of water are formed round the dust particles. This forms a cloud, which is prevented from falling by ascending currents of air.

Why does rain fall?—When air expands it cools. If the air is sufficiently moist this cooling causes rain to form. If the current of moist air ascends, the moisture in it tends to condense as rain.

It was stated in discussing the effect of wind on climate

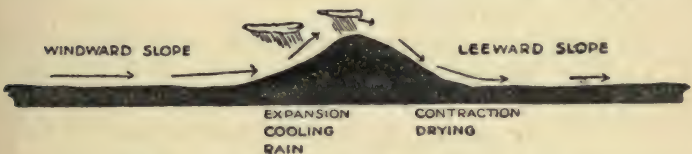


Fig. 11.—The Effect of Mountains on Rainfall.

that mountains cause rain to fall. When wet winds blow across a mountain range they are forced up into a region of low pressure. This causes them to expand and become cooler. As a result rain falls on the windward side or slope.

On the leeward side the opposite phenomenon takes place. The air falls down the slope into a region of higher pressure. This causes contraction, and there is a tendency for the wind to have a drying effect (*cf.* the Fohn wind in the Alps and the Chinook in the U.S.A. and Canada).

Why does rain fall throughout the year in the British Isles?—The British Isles lie between the main Atlantic and the great land mass of Eurasia. In winter the centre of the land mass is colder than the Atlantic. Therefore there is a higher pressure of air above Europe than above the Atlantic,

The Atlantic is a region of relatively low pressure, and its winter storms are shared by the British Isles. In summer the centre of Eurasia is hotter than the oceans, therefore it has an average lower pressure than the Atlantic. As a result, winds blow from the Atlantic across the British Isles towards Europe. Therefore rain falls in this country in summer as well as in winter.

Fog.

Fog may be defined as the conditions of the atmosphere near the ground where objects in the distance are hidden by small particles in the air. This would include small rain, sandstorms, smoke fogs. Smoke fog in London (24 miles across) will not be formed if the wind is more than one mile an hour. When two layers of air, one being moist, the other cold, meet, fog is formed by the cooling of the moist air below its saturation temperature.

(*a*) **Land Fog.**—This is formed most easily during winter and autumn anticyclones, when the sky is clear and allows the earth to radiate its heat rapidly during the nights. Coldness, where the change of temperature is less than 1° F. per 300 feet near the ground, has the effect of stopping upward currents of air which would give clouds. Thus, when inversions of temperature occur on clear nights, there is a tendency for fog to form, because a reversed temperature gradient near the surface is sufficient to suppress the turbulence produced by the friction of the air over the surface of land and sea. Fog is most generally formed in the valleys. When the sun goes down, the air at the top of the hills is cooled, because the ground cools quickly, and consequently cools the air in contact with it. Cooling makes the air denser, and the cold, heavy air falls down the hillsides into the valley beneath, where it chills the moist air, forming fog.

(*b*) **Sea Fog.**—This is formed chiefly during the summer months in British waters. In the North Atlantic Ocean, particularly round the Banks of Newfoundland, the warm saturated air above the Gulf Drift waters blows over the much

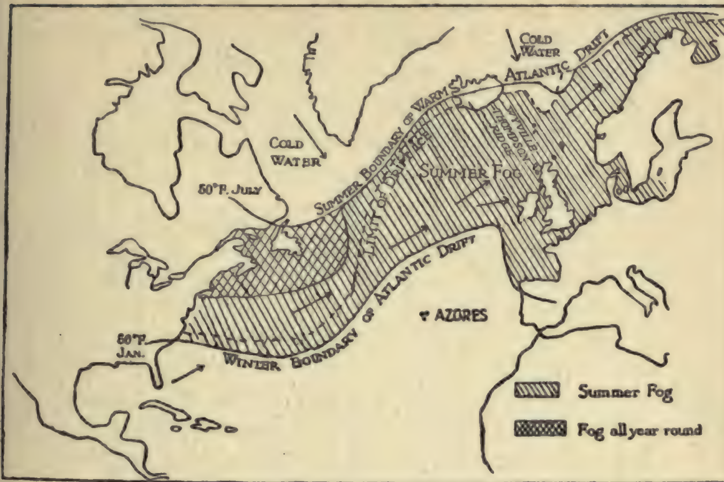


FIG. 12.—Sketch Map showing the spreading of the Atlantic fog in summer when the cold waters from the Polar regions are reinforced by melting ice.

colder waters from the north, forming dense fogs. It is for this reason that in early summer the North Atlantic is so dangerous for ships sailing by the northerly route.

PERCENTAGE OF MIST AND FOG AT SEA.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Channel . .	12	32	32	22	22	32	37	12	10	10	15	10
Irish Sea . .	17	22	22	17	17	22	17	12	12	10	20	10
North Sea (N.)	12	7	7	32	32	12	32	7	17	17	12	10
North Sea (S.)	17	17	22	22	17	22	22	10	12	15	25	10
W. Scotland .	12	12	12	10	12	10	10	12	5	10	10	5
S. Ireland . .	7	12	17	32	22	22	22	22	5	5	10	10

Conditions for forecasting the Absence of Fog during the Night.—Fog is not likely to form during the night when the sky is more than half clouded ; when the wind speed on the ground at 6 p.m. is more than 9.5 miles per hour ; when the

wind speed is more than 6 miles per hour at 8 p.m. When there is no wind at all there is considerable risk of fog, whatever the readings of the wet and dry bulb thermometers. If

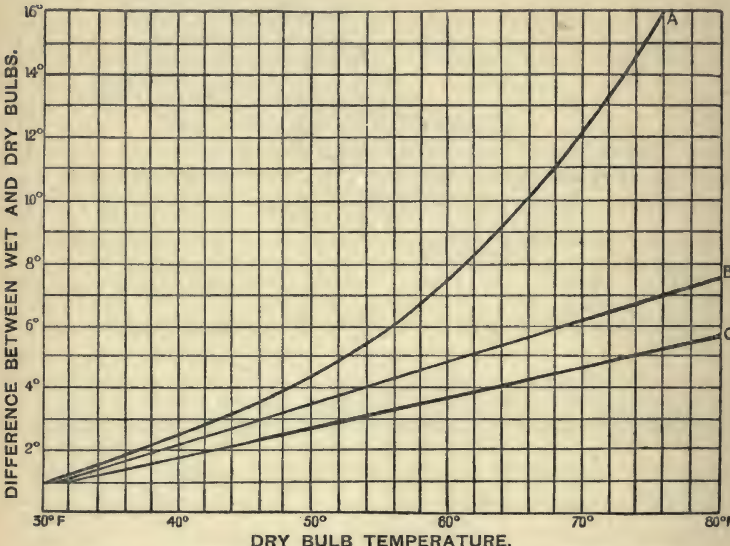


FIG. 13.—Fog Prediction Diagram. (After Major Taylor, R.A.F.)
If readings give point above—
(1) Line A at 6 p.m. fog not probable during the night.
(2) Line B at 8 p.m. fog not probable during the night.
(3) Line C fog not probable for four hours.

SCALE OF FOG.

	Scale.	On Land.	On Sea.	On River.
No mist or fog	f_o	Horizon clear.	Horizon clear.	Horizon clear.
Slight fog .	f_i	Horizon invisible ; objects indistinct at 2 miles.		
Moderate fog	f_{ii}	Traffic requires caution ; objects indistinct at 1 mile.		
	f_{iii}	Traffic impeded.	Fog signals.	Caution required.
Thick fog .	f_{iv}	Traffic impeded.	Ship lights invisible at ¼ mile or less.	Navigation suspended.
	f_v	Traffic disorganized.		

the ground has been very warm during the preceding few days there is very little likelihood of fog. Fog is twice as frequent between 2 a.m. and 4 a.m. as before 2 a.m. For winds above zero and below 8 miles per hour the risk of fog is considerable if the temperature readings are below those in the diagram.

Dew.

The ground cools more rapidly than the air at night, and chills the moist air just above it, forming dew on blades of grass and other small objects which radiate their heat rapidly. Clouds, however, tend to prevent the rapid escape of heat from the earth, so that dew, like fog, is most easily formed on clear starlit nights. On clear nights, if fog is not formed, dew generally is, unless the air is very dry, which is unusual. Experiment shows that the vapour pressure of the atmosphere diminishes from 10 p.m. to 4 a.m. as the ground cools.

In prehistoric times, when man, feeling helpless in the swampy valleys which he knew to be infested with dangerous animals, built his home on the tops of the chalk hills, the only water supply he could obtain in some places was derived from dew. "Dewponds" were hollowed out, bedded with clay and straw, and the dew was allowed to collect.

Snow.

When water vapour is rapidly chilled below freezing point the liquid is not formed, but solid snow

Hail.

Hail is frozen rain. Sometimes hail shows concentric rings showing that raindrops have been formed, have been carried upwards and frozen, have fallen, been partially melted, carried upward and frozen again. Their structure shows that they have been formed in ascending currents of air, which have whirled them aloft again and again before they finally reach the earth.

Hail often occurs in thunderstorms which develop when

currents of moist air ascend into colder regions and form big drops of rain, which are broken up into fine spray by the ascending currents of air, thus increasing the electrical charges in the clouds.

Weather Records and Forecasting.

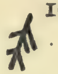
If the barometer, rain gauge, and thermometers are observed at a sufficiently large number of widely distributed places, and the results telegraphed to us as soon as they are taken, we have sufficient data on which to forecast the weather for the next few hours. A map of **North-west Europe** and the **North-east Atlantic** is made, showing the positions of the various places where the instruments are used. The readings of the barometer in millibars, thermometers in Fahrenheit degrees, and whether the barometer is rising or falling at each place, are inserted in the map ; the direction of the wind is shown by arrows, the number of feathers on which give the force of the wind on the Beaufort scale. Finally, the state of the weather is noted under the readings.

CONSTRUCTION OF WEATHER MAP FROM READINGS IN FIG. 14 (26/3/16).

Plotting the Readings.

(1.) Barometric readings and wind directions are plotted first. Suppose a place had a reading 1,010 mbs. and wind S.W. (Beaufort 5) the marking would be

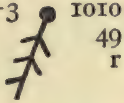
1010



showing the direction and force of the wind, and 1010 showing the pressure.

(2.) The temperature and weather would be put underneath the pressure reading. Suppose the temperature to be 49° F. and the weather rain (r Beaufort), the marking of the place would become

(3.) The tendency of the barometer to rise or fall would be added, in order to show whether the barometer had risen or fallen during the last three hours. Thus, if the barometer had fallen 3 half-millibars, the full reading would be



This is done for the whole map as the telegrams come in from the various weather stations.

In Fig. 14 Beaufort scale readings taken for March 26 (7 a.m.), 1916, are given.

Construction of the Chart by drawing Isobars.

Lines are drawn on the chart by joining places of the same barometric pressure. They are called isobars (equal-pressure lines). As a rule, they are drawn at intervals of two or five millibars. Two millibars interval is the better for small areas. In Fig. 15 isobars have been drawn for the conditions in Fig. 14.

Notice that the centre of lowest pressure is the place from which we have received reports of strong winds, storms, and rain; also that the winds tend to blow *round* the low-pressure area *along* the isobars in a *counter-clockwise* direction. Such a region of low pressure is called a **depression** or **cyclone.** Notice that squally weather occurs in a band. This band of squalls is called a **trough.**

Sequence of Weather in a Cyclone.

Since the air in front of a depression is coming from the south, and that in the rear from the north, there will be great differences in temperature between the two sets of winds.

Table of Readings :—

CYCLONE AND ANTICYCLONE.

7 a.m. 26/3/16.

Station.	Wind.	Barometer.	Temperature.	Weather.
		Mbs.	Deg. F.	Beaufort.
Lerwick . . .	S.S.E. 4	975.5	36	c
Stornoway . .	N.N.W. 7	969.8	34	o s q
Glasgow . . .	W. 4	977.5	31	bc
Malin Head . .	N.N.W. 8	981.8	40	bc q
Blacksod Point .	N.W. 4	991.7	34	c p s
Valencia . .	W. 4	997.2	40	c q p h
Holyhead . .	W. 8	988.1	39	c q g
Pembroke . .	W.N.W. 7	995.8	40	c q
Falmouth . .	W. 6	999.6	34	q p s
Jersey . . .	W.S.W. 4	1001.5	42	o
Portland . .	W. 5	997.3	40	b
Dungeness . .	W.S.W. 5	996.9	39	bc q
Aberdeen . .	W.N.W. 5	970.1	33	c
Tynemouth . .	S.W. 6	975.8	35	c q p h
Spurn Head .	S.W. 7	985.9	33	bc q
Yarmouth . .	S.W. 3	992.3	33	bc
Nottingham .	S.W. 5	989.3	35	c
London . . .	S.S.W. 4	996.3	36	b y
Bodö . . .	E. 4	999.3	14	b
Christiansund .	N.E. 4	990.6	30	b
Skudesnaes .	E. 5	982.9	36	o
Skagen . . .	S. 6	995.3	36	o
Blaavands Huk	S. 6	993.7	37	o
The Helder . .	S.S.W. 5	994.3	36	r
Cape Gris-Nez .	W. 6	997.9	40	o
La Hève . .	N.W. 5	1001.7	40	r
Brest . . .	W. 4	1003.9	33	o
Biarritz . . .	W. 3	1013.6	46	b
Paris . . .	S.S.W. 4	1004.8	39	o
Belfort . . .	W. 2	1013.1	34	c
Lyons . . .	Calm	1014.1	35	b
Nice	Calm	1009.1	51	c
Perpignan . .	Calm	1013.0	43	b
Corunna . . .	S.W. 4	1016.2	48	b
Thorshavn . .	N.E. 9	982.7	38	q
Vestmanna . .	N. 2	1010.0	26	b
Reykjavik . .	N. 8	1013.2	23	c
Seydisfjord . .	N. 6	1006.7	26	s
Hernösand . .	E. 2	1004.0	12	b
Stockholm . .	S.S.E. 2	1006.9	27	o
Wisby . . .	S. 2	1008.6	32	b

THE BEAUFORT SCALE OF WIND FORCE.

Beaufort Number.	General Description.	How observed.	Speed in Miles per Hour.	On Map.
0	Calm.	Calm; smoke rises vertically.	1–3	[o]
1	Light air.	Direction of wind shown by smoke drift but not by wind vanes.	4–7	ǀ
2	Slight breeze.	Wind felt on face; leaves rustle; ordinary vane moved by the wind.	8–12	ǀǀ
3	Gentle breeze.	Leaves and small twigs in constant motion; wind extends a small flag.	13–18	ǀǀǀ
4	Moderate breeze.	Raises dust and loose paper; small branches are moved.	19–24	ǀǀǀǀ
5	Fresh breeze.	Small trees in leaf begin to sway; crested wavelets form on inland waters.	25–31	ǀǀǀǀǀ
6	Strong breeze.	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.	32–38	ǀǀǀǀǀǀ
7	High wind.	Whole trees in motion; inconvenience felt when walking against the wind.	39–46	ǀǀǀǀǀǀǀ
8	Gale.	Breaks twigs off trees; impedes progress.	47–54	ǀǀǀǀǀǀǀǀ
9	Strong gale.	Slight structural damage occurs (chimney-pots).	55–63	ǀǀǀǀǀǀǀǀǀ
10	Full gale.	Seldom experienced inland; trees uprooted; considerable structural damage occurs.	64–75	ǀǀǀǀǀǀǀǀǀǀ
11	Hurricane.		above 75	ǀǀǀǀǀǀǀǀǀǀǀ

The Beaufort Weather Notation.

b, blue sky; *bc*, sky half clouded; *c*, sky three-quarters clouded; *d*, drizzle; *e*, air moist; *f*, fog; *h*, hail; *l*, lightning; *m*, mist; *o*, sky overcast; *p*, passing showers; *q*, squalls; *r*, rain; *rs*, sleet; *s*, snow; *t*, thunder; *u*, ugly; *v*, unusual visibility; *w*, dew; *x*, hoar frost; *y*, dry air—humidity less than 60 per cent.; *z*, dust haze.

INTERNATIONAL WEATHER SYMBOLS.

●, rain falling; ✶, snow; ▲, hail; ≡̊, light fog or mist; ≡, fog (moderate or thick); T, thunder; R, thunderstorm.

FIG. 14.—Synoptic Weather Chart—the plotting of the readings.

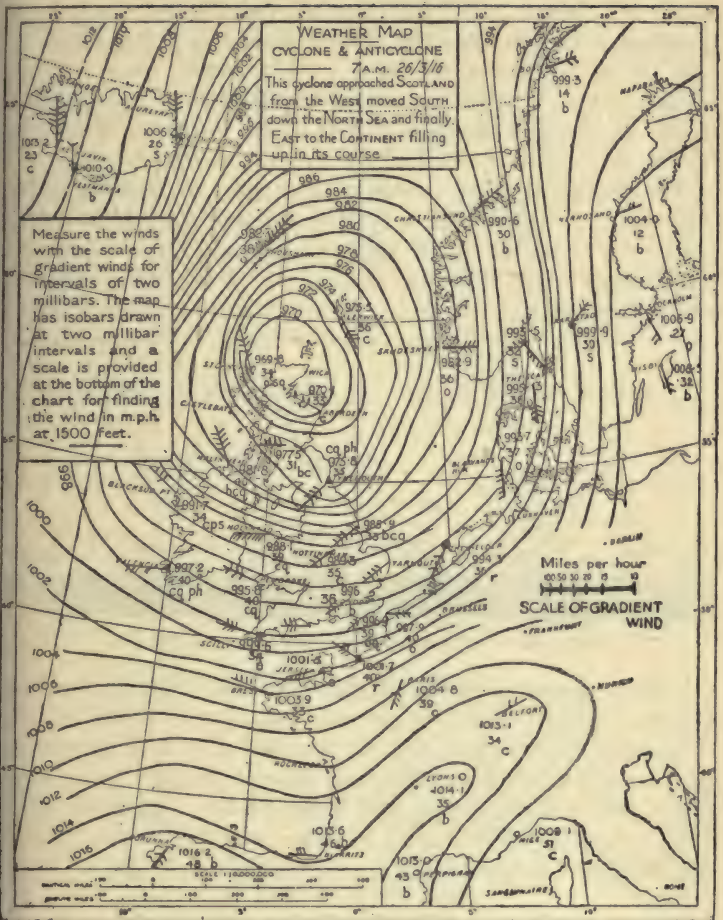


FIG. 15.—Synoptic Weather Chart—Isobars drawn at intervals of two millibars.

Moreover, the colder northerly winds (north-east to north-west) are denser than the warmer moister southerly ones (south-east to south-west). This causes the south winds to rise above the northerly ones. As a result, water vapour in the southerly winds condenses as cloud, rain, hail, or snow in the middle and north-east parts of the cyclone. The front of the depression is marked by warmer conditions than the rear. As the depression moves it carries its weather along with it. The passage of a cyclone is marked by (1) a falling barometer; (2) the wind becomes southerly (south-east to south-west); (3) the sun and moon show halos, coronæ, mock suns, and cirrus clouds form and cloud sheets gather;

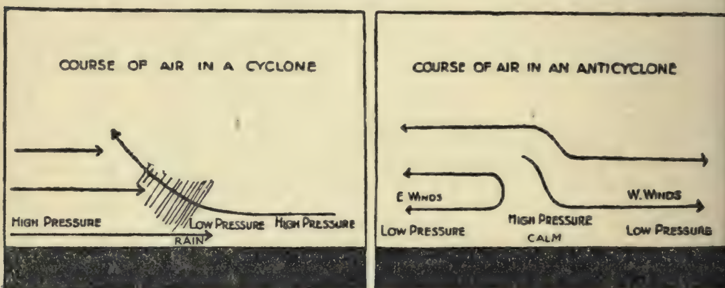


FIG. 16.—Air Currents in Cyclones and Anticyclones.

(4) drizzle begins; (5) the temperature rises; (6) the weather becomes muggy, and heavier rain falls as the centre of the depression approaches. (7) As the centre of the depression passes there are heavy squalls, and the wind changes to between north-west and north-east and blows freshly. (8) It becomes colder. (9) The sky begins to clear, and (10) as the centre moves away the wind lessens.

Cause of Rainfall in Depressions.

(1.) Interaction of two currents of air at different temperatures. (2.) The upward motion of air where two winds converge, resulting in the formation of cloud and rain unless

there is an increase of velocity to compensate for the decrease in cross-section of the current.

Find out from the map (Fig. 16) what the weather would

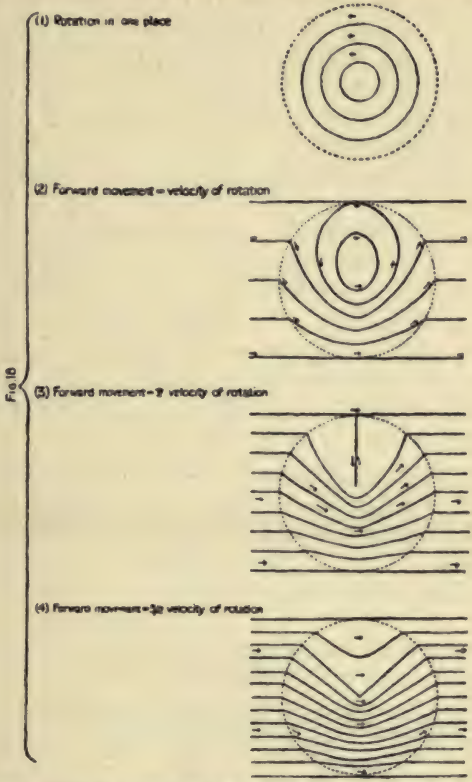


FIG. 17.—The Theoretical Shape of Isobars for Movement of Circular Storms. (After Sir Napier Shaw.)

be north of the centre of the depression, and what it would be to the south.

Speed at which a Cyclone Travels.

A cyclone never remains long in one place without filling

up. The theoretical shape of the isobars for movement is something like those shown in the following table (the cyclostropic component in the wind has been neglected).

This may mean two things: (1) That from examining the bulges in the isobars the direction in which the depression is moving may be obtained; (2) that the speed at which the depression is moving may be roughly estimated. The average speed at which cyclones move over the British Isles is about 16 miles an hour.

Let us notice now the region of higher pressure over the

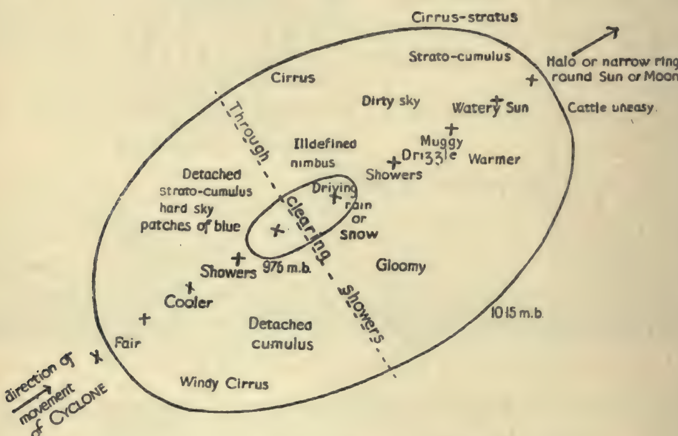


FIG. 18.—Diagram of a Cyclone.

Bay of Biscay, Southern France, and Spain. A region of high pressure is called an anticyclone or "high." Notice (1) that the winds blow in a *clockwise* direction, *round* the region of high pressure; (2) that the winds are lighter than in the cyclone; (3) that there is little or no rain; (4) that the weather is more settled.

Anticyclones move slowly; their weather and wind changes are slight.

Winter Anticyclones.

(1.) In winter the ground air often becomes stagnant and the ground radiates heat rapidly, so that the ground layers become very cold. It is not infrequent that the air a few hundred feet above the ground is warmer than the air near the ground. This is called an **inversion of temperature.** We shall expect inversions in anticyclonic weather.

(2.) If the sky is cloudy, the ground will radiate heat to the clouds; but as the formation of clouds (turning of water vapour into liquid) liberates a lot of heat, the clouds will radiate heat towards the ground. Thus a cloudy anticyclone in winter is often a period of rather mild weather.

(3.) On mountains the air is often cooled, and becomes, as a result, denser. This mass of cold air may slip down the hillside with great force, giving storms on mountain lakes (*e.g.* in Alps) or inland seas (*e.g.* the **mistral** of South France and the **bora** of North Italy). Such a dry wind is called a **Katabatic** wind, and may not be a violent one: *e.g.* cold and therefore dense air formed on hilltops slips down hill-sides, giving fogs in the valleys on clear nights, killing by freezing the plants in the valleys (*cf.* what the Americans call frost pockets), while the hill-slopes are warmer than the valleys. A similar displacement of warm and relatively light air occurs in land and sea breezes.

During the day the land is warmer than the sea; therefore the air over the sea is denser than that over the land, and displaces it by flowing underneath it—sea breeze. At night the land cools more quickly than the sea; therefore its air is colder, and in consequence denser. This gives rise to the cold **land breeze** flowing in under the warmer sea air as a cool night wind. Notice this at the seaside in summer.

Spring Anticyclones.

An anticyclone over Scandinavia in spring gives dry east winds without fog.

Summer Anticyclones.

If cloudy, the weather is relatively cool; if clear, the days are hot and the nights cool, giving pronounced land and sea breezes (night and day).

Autumn Anticyclones.

In autumn the moist air gives fog.

Buys-Ballot's Law.

Examine the map. If you stand with your back to the wind, on which side is the region of low pressure? The answer to this is called Buys-Ballot's Law: "Stand with your back to the wind, and the low-pressure area is on your left."

Gradient Wind.

The flow of air which is theoretically necessary to reduce the differences in pressure between two places is called the **gradient wind.** Its direction is along the isobars, because the velocity of the flow of air inwards towards the low pressure is balanced by the centrifugal force due to the circular motion of the air.

Tables showing the gradient wind for distances between the isobars have been constructed, and from them it is possible to estimate what the wind-speeds are at 1,500 feet, where the wind is free from the friction of the earth's surface.

Computation of Wind Velocities at various Heights by Means of Pilot Balloons.

It is assumed that the rate of ascent of a balloon is constant. If L be the free lift—*i.e.* the weight the inflated balloon will support in addition to the weight of rubber and attachments—and W is the weight of the balloon and attachments, the total weight the balloon will support is W+L. It has been found by experiment that the lifting velocity $\text{L.V.} = \frac{q\sqrt{L}}{\sqrt[3]{W+L}}$ metres per minute, where $q=83$; or when feet per minute are used, $q=276$.

Method.—The balloon is released, and its elevation and azimuth from north are read at the end of each minute by means of a theodolite. t is the time in

TABLE OF GRADIENT WINDS.

TABLE SHOWING THE DISTANCES APART IN NAUTICAL MILES OF CONSECUTIVE 10 MILLIBAR ISOBARS CORRESPONDING WITH STATED GEOSTROPHIC WIND VELOCITIES IN LATITUDE 52°.

T/p. . . .		.26	.27	.28	.29	.30	.31
Pressure p.		Temperature T (absolute degrees).					
1050 millibars .		273°	284°	294°	305°	315°	326°
1000 " .		260°	270°	280°	290°	300°	310°
950 " .		247°	256°	266°	275°	285°	294°
Gradient Wind Velocity.		Distance apart in Nautical Miles of Consecutive 10 Millibar Isobars.					
mi./hr.	m./s.						
2.2	1	3510	3645	3780	3915	4050	4185
4.5	2	1755	1823	1890	1958	2025	2093
6.7	3	1170	1215	1260	1350	1350	1395
9.0	4	878	911	945	979	1013	1046
11.2	5	702	729	756	783	810	837
13.4	6	585	608	630	653	675	698
15.7	7	501	521	540	559	579	598
17.9	8	439	456	473	489	506	523
20.1	9	390	405	420	435	450	465
22.4	10	351	365	378	392	405	419
24.6	11	319	331	344	356	368	380
26.8	12	293	304	315	326	338	349
29.1	13	270	280	291	301	312	322
31.3	14	251	260	270	280	289	299
33.6	15	234	243	252	261	270	279
35.8	16	219	228	236	245	253	262
38.0	17	206	214	222	230	238	246
40.3	18	195	203	210	218	225	233
45	20	176	182	189	196	203	209
50	22	160	166	172	178	184	190
55	25	140	146	151	157	162	167
60	27	130	135	140	145	150	155
70	31	113	118	122	126	131	135
80	36	98	101	105	109	113	116
90	40	88	91	95	98	101	105
100	45	78	81	84	87	90	93

From this construct a ruler for intervals of 2 millibar intervals showing 5, 10, 20, 30, 40, 50, and 80 miles per hour for size of map you use for weather charts.

minutes, A° the azimuth from north, E° the angle of elevation, h the assumed height=L.V.t, horizontal distance travelled=h cot E, D_{WE} is the horizontal distance travelled towards the east, D_{SN} is the horizontal distance travelled towards the north. The resultant horizontal velocity makes an angle ϕ with north.

ϕ is found from the equation $\tan \phi = \frac{V_{WE}}{V_{SN}}$.

Then V is found from the equation $V = \frac{V_{WE}}{\sin \phi} = \frac{V_{SN}}{\cos \phi}$.

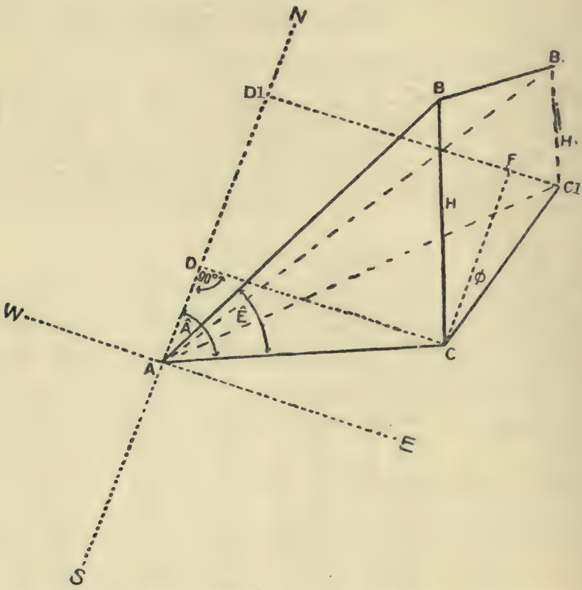


FIG. 19.—Diagram illustrating the Pilot Balloon Computation.

Proof.—The balloon is released from A, and is at B at the end of the first minute, and at B at the end of the second minute.

Then BC=h,
AC=h cot E,
ADC=90°.
Therefore $D_{SN}=AD=AC \cos A=h \cot E \cos A$,
and $D_{WE}=DC=AC \sin A=h \cot E \sin A$.

Consider the second and successive minutes.

At the end of the second minute $C_1D_1=D_{WE}$ and $AD_1=D_{SN}$.

The displacements during the second minute are represented by FC_1 and DD_1.

$$\text{Hence } \tan\phi = \frac{FC_1}{FC} = \frac{FC_1}{DD_1} = \frac{Vel_{WE}}{Vel_{SN}},$$

$$\text{while } V = \frac{V_{SN}}{\cos\phi}. \quad \text{Similarly with successive minutes.}$$

Types of Weather.

(1.) **High-pressure Wedge.**—From the readings for 7 a.m. 14/1/18 construct a weather map. Notice that the wedge of high pressure is between two regions of low pressure, and indicates calmer conditions and better weather than the cyclonic type. In winter the wedge is generally marked by cooler, finer weather than the cyclonic type.

(2.) **A Col** is a region of low pressure between two highs, and though only shallow the weather is less settled than in the anticyclones.

(3.) **Secondary Depression.**—Make a map for 6 p.m. 21/2/18, and notice how the gradient is reduced (*i.e.* there is a greater distance between the isobars, and consequently there is a reduction of wind) on the side nearest the main region of low pressure. (**What is the wind velocity in the North Sea?** Use your gradient scale.) Notice also how the gradient is increased between the centre of the secondary and the region of high pressure. For this reason secondary depressions are frequently the cause of severe storms and squalls with heavy rain.

(4.) **V-shaped Depressions.**—When the secondary depression is V-shaped the low pressure takes a much shorter time to pass over a point. Thus the change in wind is very rapid, generally a change from south-south-west to north-north-west in a few minutes. The passage of a trough over a point is generally marked by heavy rain and squalls. In the example given, 12/3/18, the depression is very shallow, and little disturbance took place. The cause of V-shaped depressions is north-west cool high-pressure systems flowing under and displacing south-west warmer systems. Often this gives thundery conditions.

(5.) **Line Squalls.**—Line squalls are seldom shown on a weather map, because the **V** notch in the isobars can seldom be recorded at any particular place unless the station has self-recording instruments. The squall often travels at 30 miles an hour or more. It is characterized by a sudden squall, veering of wind, heavy showers, rise of barometer, and sudden fall of temperature. It is due to a flood of cold air displacing a warmer southerly wind system. The warmer air is compelled

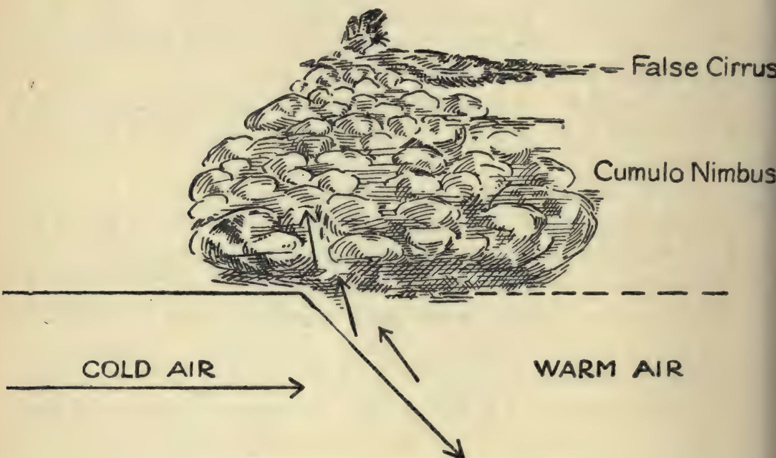


Fig. 20.—Diagram of a Line Squall.

to rise very rapidly, giving cloud, rain, snow, hail, and frequently thunderstorms. In summer the weather before the squall is warm and bright, and afterwards colder and bright again, the line of clouds marking the junction of cold and warm air.

Other Types.

A cyclone to the north-west of the British Isles gives *west and south-west types*, with warm moist west or south-west

winds bringing rain (warm weather in winter and cool weather in summer).

An anticyclone over the northern North Sea gives hot weather in summer, but intensely cold weather in winter—*easterly type*. An anticyclone over the north-west or west of the British Isles gives bitterly cold weather with "black frosts" in winter. This *northerly* type, like the *easterly* type, is dry.

TYPES OF WEATHER.—HIGH-PRESSURE WEDGE.

7 a.m. 14/1/18.

Station.	Wind.	Barometer.	Temperature.	Weather.
		Mbs.	Deg. F.	Beaufort.
Lerwick . .	N.N.W. 3	1009	18	c
Stornoway . .	S. 5	1008	27	q
Glasgow . .	S.S.E. 1	1012	12	g
Malin Head .	S. 6	1007	22	q
Blacksod Point	S. 7	1004	36	r
Valencia . .	S.S.E. 4	1008	42	r
Holyhead . .	S. 4	1013	30	b
Pembroke . .	S. 4	1014	36	p
Scilly . . .	S.W. 3	1013	45	o
Jersey . . .	S.W. 3	1017	40	b
Portland . .	S.W. 3	1016	35	r
Dungeness . .	N.N.W. 1	1017	31	o
Aberdeen . .	S.S.W. 2	1012	17	b
Tynemouth .	N.N.W. 2	1015	15	b
Spurn Head .	N.N.W. 4	1016	24	q
Yarmouth . .	N.W. 3	1015	23	m
Nottingham .	S. 1	1017	24	o
London . .	N.N.E. 2	1018	30	m
Christiansund .	S.W. 5	1000	27	c
Skudesnaes. .	S.S.E. 6	1006	27	o
Skagen . . .	S.E. 3	1010	27	c
Blaavands Huk	S.S.W. 3	1006	23	s
Bornholm . .	S.S.E. 3	1010	23	bc
The Helder .	W. 7	1012	32	c
Brest . . .	S.W. 4	1016	43	bc
Thorshavn . .	N.W. 3	1006	14	o
Abbeville . .	N. 1	1017	32	s

TYPES OF WEATHER—SECONDARY (WITH SOUTH-WEST AND WEST TYPES IN IRELAND AND CHANNEL).

6 p.m. 21/2/18.

Station.	Wind.	Barometer.	Temperature.	Weather.
		Mbs.	Deg. F.	Beaufort.
Lerwick . . .	S. 4	997.5	39	o
Stornoway . . .	S.W. 7	991.0	47	o r q
Glasgow . . .	S.W. 5	1004.7	43	o r q
Malin Head . .	S.W. 7	1001.9	47	o m g p
Blacksod Point .	S.W. 8	1001.8	47	o m r
Valencia . . .	S.W. 6	1019.0	50	o
Birr Castle . . .	S.W. 2	1014.9	47	r
Holyhead . . .	S.W. 5	1016.2	46	o p q
Pembroke . . .	S.W. 6	1022.5	47	c
Scilly	W. 6	1027.7	48	c
Jersey	W. 3	1029.3	47	b
Portland . . .	W. 4	1028.9	46	bc
Dungeness . . .	S.W. 3	1024.4	43	bc
Aberdeen . . .	S.S.W. 3	1001.5	41	o
Tynemouth . .	S.W. 4	1011.5	43	c m q r
Spurn Head . .	W.S.W. 4	1017.5	43	c q
Yarmouth . . .	W. 3	1020.2	46	o
Nottingham . .	S.W. 3	1019.0	41	b
London	S.S.W. 2	1024.3	44	o
Christiansund . .	S.S.E. 2	1001.2	34	c
Skudesnaes . .	S.E. 6	1007.0	30	o
Skagen	N.E. 4	1007.4	25	o
Blaavands Huk .	N.N.W. 2	1012.6	30	c
Copenhagen . .	N.N.W. 4	1001.4	28	o
Bornholm	W. 10	995.0	32	m
The Helder . .	W.S.W. 4	1019.8	41	c
Cape Gris-Nez . .	W. 4	1024.0	44	c
Rochefort . . .	W.N.W. 3	1032.0	47	b
Biarritz . . .	W.S.W. 3	1031.2	50	o
Paris	W.N.W. 2	1029.0	45	b
Belfort	W. 4	1029.5	35	r
Lyons	Calm	1030.0	39	o
Nice	E. 4	1024.2	44	bc
Perpignan . . .	N.N.W.	1029.1	52	bc
Corunna . . .	N.N.E. 1	1033.9	54	c
Thorshavn . . .	S. 4	997.5	39	o
Faerder (Christiania)	N.E.	1010.7	23	o

TYPES OF WEATHER.—V-SHAPED DEPRESSION (VERY SHALLOW).
7 a.m. 12/3/18.

Station.	Wind.	Barometer.	Temperature.	Weather.
		Mbs.	Deg. F.	Beaufort.
Lerwick . . .	S.W. 4	1007	44	o m
Stornoway . . .	W.S.W. 5	1009	41	bc q
Glasgow . . .	S.W. 2	1014	40	c m
Malin Head . .	S. 3	1013	42	c q
Blacksod Point .	S.W. 3	1015	41	bc
Valencia . . .	W.S.W. 2	1017	39	c
Birr Castle . . .	S. 1	1016	35	bc
Donaghadee . .	W. 2	1014	39	o g m
Holyhead . . .	N. 3	1015	42	o
Pembroke . . .	N.N.W. 2	1015	43	o
Scilly	N.W. 1	1016	44	c d
Portland . . .	S.S.W. 3	1015	46	c
Dungeness . . .	S. 1	1017	42	b
Aberdeen . . .	W. 2	1012	45	o
Tynemouth . .	W. 1	1013	45	o m
Spurn Head . .	S.S.E. 2	1015	42	c m
Yarmouth . . .	S.S.W. 2	1016	41	bc m
Nottingham . .	S.S.W. 1	1015	43	bc
Bodö	E. 1	1016	34	b
Christiansund . .	S.S.E. 1	1011	43	o
Skudesnaes . .	E.S.E. 3	1014	39	f
Skagen (The Skaw)	Calm	1018	36	f
Blaavands Huk .	S. 1	1020	36	o
Copenhagen . .	Calm	1021	36	f
Bornholm . . .	W.S.W. 3	1020	32	f
The Helder . . .	S.S.E. 2	1019	34	b
Cape Gris-Nez . .	S. 2	1018	44	b
Brest	N.N.W. 4	1015	46	f
Rochefort . . .	E. 2	1017	41	b
Paris	Calm	1020	30	b
Thorshavn . . .	S.W. 6	996	42	o
Vestmanna . . .	W. 5	979	39	c
Reykjavik . . .	S.W. 5	977	36	o
Seydisfjord . . .	Calm	977	39	r

Draw the isobars at 2 mbs. intervals for odd numbers (for 1015, 1013, 1011, etc.). This V-shaped depression was very shallow. As a result violent winds were not experienced. Measure the gradient winds, and explain where the regions of high pressure and low pressure are.

Upper Air Temperatures.

Temperature of the upper air can be recorded and graphed on the same scale as Fig. 10. If the conditions are cyclonic,

the graph shows it. If inversions and isothermal curves, the conditions are anticyclonic. If the curve is parallel to the line of adiabatic cooling for dry air, the weather will be unsettled.

Humidity.

Humidity is taken into account to determine the likelihood of fog or dew occurring. This is especially of importance in allowing airships to fly.

Thunderstorms.

These are due to rapid upward currents of air being rapidly cooled, forming a cloud of raindrops which break up into fine spray. This breaking up of the drops increases the electrical charges carried by the drops, and tends to make things suitable for electrical discharges. The cloud formed is called **cumulo-nimbus,** and has a cauliflower appearance. It can be seen to grow upwards with the naked eye, and sometimes reaches a height of 15,000 feet in a few minutes. Thunderstorms occur (1) at the end of hot, sunny weather (shallow depressions); (2) in a col of low pressure in summer; (3) in line squalls.

What is the Use of forecasting Weather?

(1.) **Agricultural Use of Forecasts.**—If a gardener knew that a late frost was going to occur, he would not leave the cover off his frames at night. The U.S.A. forecasts are issued chiefly to warn agriculturists of the probability of frost.

(2.) **Storms at Sea.**—Ships would not put to sea if a violent gale were expected to spring up. The British Meteorological Office warn all ports, by storm warnings, of the approach of gales, estimated, as a rule, from gradient winds—*i.e.* closeness of isobars.

(3.) **Traffic.**—Omnibuses carry more passengers in fine weather, but in wet weather tubes are used more. Forecasts are issued to each, thus allowing the companies concerned to

make arrangements for accommodation. Trains are delayed by fog. Knowledge of the likelihood of fog enables railway companies to make arrangements in time.

(4.) **Airships, Aeroplanes, and Air Raids.**—Airships require knowledge of the weather 2,000 to 10,000 feet up. No pilot will take a machine up if a storm is brewing, unless absolutely necessary. He cannot easily fly in low clouds, nor can he land in a fog. Air raids used to be conducted during anticyclones. Knowledge of coming weather was necessary both for attack and defence.

(5.) **Coal Mines.**—Some mines become more dangerous in fine weather. Colliery warnings are issued to the collieries which desire them.

(6.) **Cinema Actors** require fine weather, as a rule, for the photographs to be taken, and regularly obtain forecasts.

(7.) **Outdoor Meetings and Entertainments** suffer if the weather is bad. Forecasts are useful. Queries such as the following are sometimes received: "Mrs. X. giving garden *fête* to-morrow afternoon; what is weather likely to be?" Or, "Mr. Y. wishes to know whether conditions favourable for flying pigeons from Paris to Durham to-morrow." The fact that private individuals, companies, leaders of armies, navies and merchant fleets, farmers and pitmen require forecasts, and are willing to *pay* for them, shows that forecasting is no longer mere guesswork, and that its value is beginning to be recognized.

Summary of Things to be taken into Account when Forecasting.

(1.) Non-instrumental Observations.

(*a*) **Halos round Sun or Moon.**—Coronæ and mock suns precede depressions.

(*b*) **Clouds.**

TABULAR STATEMENT OF THE SEVERAL TYPES OF CLOUDS.

(*a*) Cloud Sheets.

Upper cloud layer about 30,000 feet. Clouds composed of ice crystals. With these are sometimes seen halos, or rings, at some distance from the sun and moon.	*Cirrus.*—Mares' tails; wisps or lines of pure white clouds with no shadows. *Cirro-cumulus.*—Small speckles and flocks of whity clouds; fine ripple clouds; mackerel sky. *Cirro-stratus.*—A thin sheet of tangled web structure, sometimes covering the whole sky; watery sun or moon. *Cirro-nebula.*—Similar to last, but a veil of cloud with no visible structure.

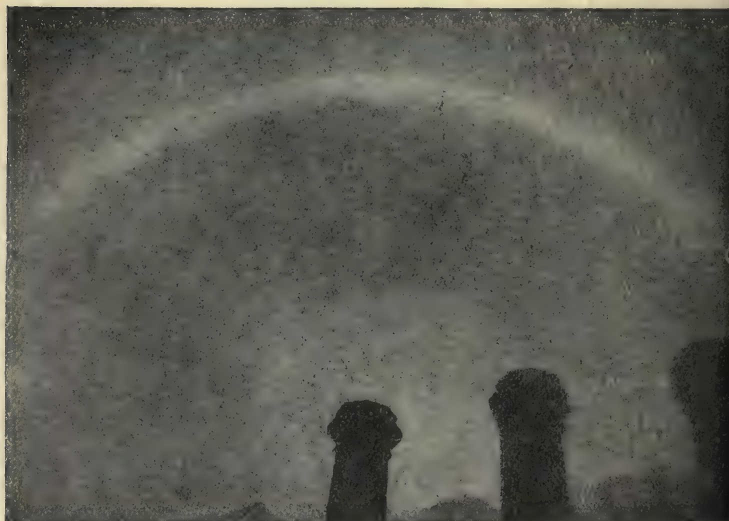


FIG. 21.—Photograph of a Solar Halo.
(*By kind permission of Mr. G. A. Clarke, Aberdeen.*)

Middle cloud layer; 10,000 to 25,000 feet. Clouds composed of minute drops of water. Coloured rings sometimes seen quite close to the sun and moon, but never halos.	*Alto-cumulus.*—Somewhat similar to cirro-cumulus, but the cloud masses are larger, and show some shadow. *Alto-cumulus castellatus.*—Turret cloud; alto-cumulus with upper margins of the cloud masses developed upwards into miniature cumulus, with hard upper edges. (Sign of thunder.) *Alto-stratus.*—Very like cirro-stratus and cirro-nebula, but a thicker and darker cloud.

Lower cloud layer. Below 7,000 feet.

Stratus-cumulus.—Cloud masses with some vertical structure; rolls or waves sometimes covering the whole sky.

Stratus.—A uniform layer of cloud resembling a fog, but not resting on the ground.

Nimbus.—Shapeless cloud without structure, from which falls continuous rain or snow.

Scud.—Small shapeless clouds with ragged edges; sometimes seen without other cloud, especially in hilly country; but more commonly seen below other clouds, such as cumulus and nimbus.

(*b*) **Heap Clouds.**

Cumulus (woolpack clouds).—Clouds with flat base and considerable vertical height. Cauliflower-shaped top.

Fracto-cumulus.—Small cumulus with ragged tops.

Cumulo-nimbus (anvil, thunder, or shower cloud).—Towering cumulus with the top brushed out in soft wisps or larger masses (false cirrus), and rain cloud at base.

The height of the heap clouds is very variable. Mean height of base, about 4,500 feet; the height of the top varies from about 6,000 to 25,000 feet.

(2.) Observations with Instruments.

a) **Barometric pressure** and tendency of pressure to rise or fall shown on isobar maps.

(*b*) **Wind Direction and Force.**—Upper wind from pilot-balloon observations or from gradient wind table.

(*c*) **Temperature.**—Marked rises or falls—temperature inversions in fine weather.

(*d*) **Humidity.**—From wet and dry bulb thermometers—giving likelihood of fog or dew.

Local Considerations affecting Local Climate.

(1.) Southerly aspect gives more sun and milder climate.

(2.) Woodland is less extreme than moorland: *e.g.* Kew seldom registers more than two-thirds of wind force at Farnborough.

FIG. 22.—Cloud Photographs.

1. High Cloud—Cirrus. 2. Middle Cloud—Alto-Cumulus. 3. Heap Cloud—Cumulus. 4. Low Cloud—Stratus.

(3.) Valleys may be frost pockets.

(4.) Soils, if well drained, are less liable to fogs than clay soils.

(5.) Towns artificially heated are warmer than open country in winter.

Questions and Exercises.

(1.) Write a short account of the system of currents in the Atlantic.

(2.) Name and describe the planetary winds in the northern hemisphere. What are the causes which modify the planetary circulation in Western Europe? What modifications occur in January, in July? How do you account for (*a*) a strong westerly gale in the English Channel; (*b*) a dry easterly wind in Norfolk? At what times of the year is each likely to occur?

(3.) What are "oceanic" and "continental" climates? Illustrate by comparison of the differences between Edinburgh and Moscow, which are practically in the same latitude.

(4.) The average temperature at Cape Wrath is approximately the same as that of the Isle of Wight, whereas in July it is 7° F. lower. Account as fully as possible for these facts. In what parts of the British Isles are the most extreme and most equable climates to be found?

(5.) What parts of the west coast of England and Wales have (*a*) the greatest rainfall; (*b*) the least rainfall? Account for the facts.

(6.) Describe the method of measuring rainfall. Explain the phrase "the annual rainfall of Southamption is nearly 30 inches." Name one English district receiving more and one receiving less than this quantity, and account for the contrast.

(7.) The weather forecast for the London district on a certain date was: "Strong south-easterly gales, veering to north-west, and moderating later." State and explain the chief facts that would justify this forecast.

(8.) On a certain day a deep cyclone is midway between Labrador and the British Isles. Draw a sketch map showing the North Atlantic and the surrounding countries. Insert isobars showing the cyclone. Describe the weather (*a*) in Labrador; (*b*) in the British Isles.

(9.) The following readings were taken on successive days:—

Day.	Barometer, in Inches.	Direction of Wind.	Dry Bulb.	Wet Bulb.	Rain.
Monday, 7 a.m.	29.9	S.W.	50° F.	48° F.	...
7 p.m.	29.5	S.E.	51°	50°	·01 cm.
Tuesday, 7 a.m.	29.1	S.E. to N.W.	50°	53°	} 2.34 cm.
7 p.m.	29.5	N.W.	45°	40°	
Wednesday, 7 a.m.	30.3	No wind.	41°	34°	..

What inferences can be drawn from the data?

(10.) The following paragraph gives the average annual rainfall from 1875 to 1909. From it construct a rainfall map of the North of England, showing areas of 20 inches to 30 inches, 30 inches to 40 inches, 40 inches to 60 inches, above 60 inches annual rainfall. Rainfall in inches:—

Leicester, 26.4; Boston (in Lincolnshire), 23.3; Louth, 28.7; Nottingham, 24.46; Macclesfield, 34.7; Southport, 32.7; Sedburgh (Whernside), 52.1; Skipton, 29.9; Ingleborough, 58.0; York, 24.8; Pen-y-gent, 61.5; Harrogate, 26.9; Hull, 26.4; Middlesborough, 24.1; Wolsingham (Durham), 33.7; Sunderland, 26.0; Allendale (Northumberland), 34.2; Alnwick (North), 28.9; Seathwaite (Coniston Old Man), 129.5; Appleby, 34.4; Hawick, 33.8.

(11.) The following are average temperatures for the month of January:—

Cape Wrath, 40; Glasgow, 39; Belfast, 42; Dublin, 42; Liverpool, 38; Anglesey, 41; Birmingham, 36; Cardiff, 40; Bristol, 41; Oxford, 39; Brest, 44; Paris, 35; Lyons, 36; Bordeaux, 43; Marseilles, 42; Genoa, 43; Milan, 39; Trieste, 40; Athens, 48; Vienna, 29; Berlin, 30; Brussels, 35;

Hamburg, 34; Christiania, 28; Bergen, 32; Copenhagen, 31; Constantinople, 40. Draw the isotherms for 40 and 32. What do you infer from the map made?

(12.) What reasons do you know for the differences shown between the following pairs of average temperatures (monthly)? Draw graphs comparing the different ranges of monthly temperatures.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
London and	37.0	39.0	41.0	45.0	53 0	59.0	62.0	61.0	55.0	46.0	43.0	40.0
Vienna	30.0	33.0	41.0	50.0	59.0	65.0	68.0	66.0	61.0	51.0	38.0	30.0
Fort William and	39.0	39.1	41.1	45.5	50.0	55.7	57.3	57.0	53.3	47.6	41.8	39.9
Ben Nevis	23.8	23.9	24.8	27.7	33.3	39.0	40.5	39.8	37.9	31.0	28.1	25.0

(13.) Draw a map from the readings of the daily weather report, and estimate the winds. Write an account of the present weather as shown on the chart. Describe what you think will happen, giving reasons for your forecast.

(14.) How are weather forecasts made? Why was none published in the newspapers during the Great War? Draw a weather chart of the British Isles, indicating a cyclonic system over the Midlands.

(15.) What weather considerations have to be taken into account when it is proposed to have a flight in an aeroplane: (*a*) by night; (*b*) by day?

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CHAPTER II.

PLANTS AND ANIMALS.

THE conditions which modify plant life are **heat, water, light,** and **soil.**

Heat.—Below certain temperatures seeds cannot germinate, and growth is impossible. If a rapid thaw succeeds a frost many plants are killed.

Water.—Lack of water diminishes the size of a plant—*e.g.* wet seasons are good for hay, roots, and most of our crops, while dry seasons are good for small fruits.

Light.—Light prevents the growth of the stalk, and thus causes the early ripening of fruits.

Soil.—Soil contains the necessary foods which are taken in by the roots of the plants.

The Chief Types of Vegetation.

On the plateaux there are **moorlands.** When the soil is limestone the plateaux bear grass, while on the sandstone there is often a lot of heather.

On the hill slopes the upper parts are covered with conifers and hardy deciduous **trees,** such as the mountain ash; while the lower slopes, with a more abundant water supply and a deeper soil, are covered with deciduous trees—oaks, beeches, chestnuts, sycamores, and such fruit-bearing trees as apples, pears, plums, and cherries. Britain is typically a region of temperate woodlands, but a very large proportion of her ancient forests have been cut down and the land used for the cultivation of cereals, root crops, and for pasture.

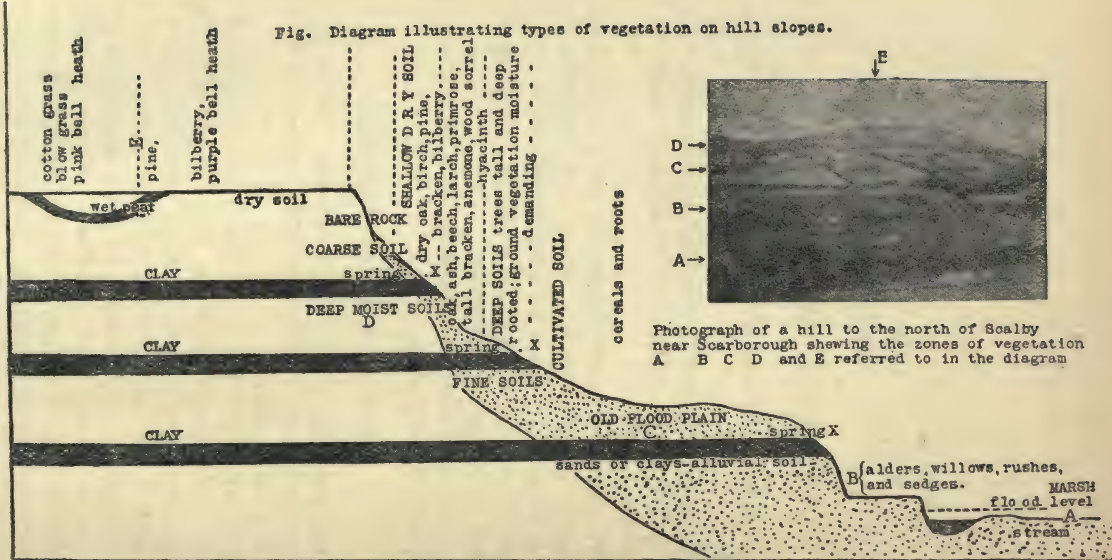

FIG. 23.—Diagram illustrating the Types of Vegetation.

In the plains and valleys **grasslands** are found. Much of this natural grassland is now cultivated, but there is more land still used for the feeding of cattle and sheep than for the growing of wheat and other corn crops.

Other Types.

Fenland.—Fenland is formed on deep peat which contains a large amount of mineral salts—generally in shallow estuaries which have been filled with silt, tidal mud, and reedy marsh plants. Its soil is very rich, and, when cultivated, yields splendid crops.

Salt Marshes are formed near certain coasts, and form excellent pasture, though at present they are often used as golf links. It would be possible to plant trees on the salt marshes.

Woodlands and the Rocks they grow on naturally.

Alluvium is the home of the willow, ash, alder, and poplar. Dry sandy soils are suited to the growth of oak, birch, beech, pine. These have all too frequently degenerated into heaths. On the older siliceous rocks the oak grows ; the beech also, but going up in this case to the highest peaks. The destruction of the beech forests has been due to (1) the growth of peat ; (2) the process of cutting down timber in order to create pasture ; and (3) the natural degeneration of the woods into scrub, and scrub into grassland. Except where oak has left bracken, which gains on grassland in some places, most of the **woodlands** have become **grassland.** The forests of North-east Scotland, which were formerly very extensive, have degenerated into heather moors. On the chalk the beech and the yew have become grass. The ash woods of the Carboniferous and Oölitic limestones have become valuable grasslands. On the clay alone have the oak forests been preserved, and only then for the game they harbour. The rest of our primeval forests have long since become grassland.

THE CHIEF FOOD CROPS.

WHEAT.

(1.) **Conditions of Growth.**—(*a*) A moist sowing and growing season, with a warm summer temperature (over 60° F.); or, if it is sown as a winter crop, the winter must be mild—*e.g.* in the north-west of Europe the wheat is sown in spring, while in the Mediterranean it is grown as a winter crop.

(*b*) Sunlight. Much sunlight gives the highest quality of grain. As a matter of fact, English wheat as a rule is not of the quality best suited for the finest flours, and in many mills is mixed with the harder imported grain. It is noteworthy that, owing to the long hours of sunshine in summer, wheat can be grown as far north as the Arctic Circle. Thus parts of the Eastern Lowlands of Scotland produce a fine grain, though the harvest there is somewhat later than in England, where the crop is taken in the hot and sometimes dry days of late July and August.

(*c*) A clay soil or a well-manured loam produces the best crop. In a short time, however, wheat exhausts the soil of nitrogenous constituents, so that frequent manuring is necessary if the land is to continue to produce crops. To replenish the soil with nitrogen compounds the system of the **Rotation of Crops** is very frequently adopted. It is known that peas, beans, and certain root crops can grow on soils which have been exhausted of their nitrogen compounds by wheat. Moreover, their roots have the power of replenishing the soil with compounds of nitrogen suitable for the growth of wheat. As a result, peas, beans, and roots are grown between the years when wheat is sown. Sometimes white mustard is grown and then ploughed into the field. Vetches are found to have a still greater effect in replenishing the soil. Thus it is not absolutely necessary to allow the field to remain fallow to recover its fertility.

The early rotation practised in the British Isles was wheat, oats, and fallow. The third season was thus one of poverty. Probably it was this that caused the mediæval farm, manor, or village to be divided into three fields, so that one of the fields would produce wheat, one oats, and one would be fallow each year. Since the beginning of the eighteenth century the following systems have been used: Wheat, barley, oats, beans and peas, and wheat. The following is a specimen of the rotation practised on a Yorkshire field: 1910, Turnips and potatoes. 1911, Barley and wheat. 1912, Seeds, peas, and beans. 1913, Oats.

The parts of the British Isles which produce wheat are those where the soil is fertile, where the rainfall does not exceed 33 inches per annum, where the height of the land does not exceed 800 feet, and where the July temperature is above 56° F. Roughly speaking, these conditions are satisfied south-east of a line from Scarborough, to Knaresborough, to Nottingham, to Exeter. This area does not produce more than one-fifth of the wheat consumed in the United Kingdom, even though the yield is often as large as 30 bushels an acre.

In Europe the period when it was not necessary to use manure has passed, the marshes have been very largely reclaimed, and now form the best wheat land. With the opening out of the great plains of North America a new wheat field was created which for a long time did not need manuring. Consequently, American wheat has till now been produced far more cheaply than British wheat. The British do not need fresh wheat, and so are contented with a cheap imported supply. It is otherwise with meat, which we desire freshly killed. As a result, the greater part of the productive land is given over to the growth of grasses and cattle crops, because "wheat does not pay as well." It is significant, however, that even in the wonderful soils of Minnesota the use of manures is becoming necessary, and it is quite possible that in the course of a few years we shall have to increase the area under

wheat at the expense of the land under other grains and cattle crops.

The sources of the imported wheat supply are the U.S.A., India, Argentine, Russia, and Canada. The amount obtained from each varies considerably from year to year, though the greatest amount generally comes from the U.S.A.

Oats.

Oats can be grown on moister soils and at a lower temperature than wheat. Thus for the rest of the British Isles oats is the chief grain. A good deal of oats is grown in the south-east of England. It is used as food for horses, while large numbers of people use oats in the form of porridge on the breakfast table.

Barley.

Barley can be grown in cool or hot, damp or dry climates, on poorer soils than either wheat or oats. Naturally there are wide limits of cultivation. It is grown in the north of Central Europe, while in the Mediterranean it has been cultivated since the time of the Old Testament. The kind of barley varies according to the different climates in which it is grown. In the north-west of the British Isles the climate is too wet for the production of a good brewing grain. Accordingly, we find that the national intoxicating drink of Scotland and Ireland is whisky (Irish, *usquebaugh*). In the Midlands and South-east England the fine grain is used for brewing, while the coarse grain is given to the pigs, for both of which the south-east counties are famous. On the other hand, the centre of Europe is too dry for the production of a barley from which a very strong intoxicating liquor can be made. Thus the Bavarian lager is not much more intoxicating than our hop bitters. In fact it is by no means unusual for a German to drink from seventeen to twenty glasses without becoming intoxicated.

POTATOES.

Like barley, the potato can be cultivated almost anywhere. It is unable to withstand frost during its early growth, and is generally planted about Easter time in England. The exceptionally mild climate of parts of the south-western peninsula of England, the Scillies, and the Channel Islands, makes it possible for these parts to obtain early potatoes and vegetables months before they are fit for consumption in any other part of the British Isles. The potato requires a deep sandy loam, which should be well drained. The potato is the chief food plant of North Germany and Ireland; in England and Scotland it is grown almost universally, but the eastern counties, Yorkshire, the Lowlands, and Banff, are the greatest producers.

By-products of Potato Industry.

(1.) **Starch.**—The potato can be used for the making of starch. From starch it is possible to obtain a whole series of useful substances. About 15 to 20 per cent of the potato is starch. In England starch is prepared chiefly from rice, while potatoes are used in Germany, and maize in the U.S.A. In each case the material is softened and crushed, and then washed through revolving cylinders, covered with gauze or silk, which act as sieves, allowing the starch granules through but keeping back the other substances. Finally, the starch is dried. Starch is used for sizing and stiffening paper, and for the making of British gum.

(2.) **Glucose** (grape sugar).—When starch is boiled with dilute sulphuric acid glucose is formed. It is used in the manufacture of confectionery, the preserving of fruits and jam, the making of wines, liqueurs, and as a substitute for malt in the brewing of beer. Glucose is a cheap source of alcohol. If yeast is added to a solution of grape sugar, alcohol is formed, and may be separated by distillation.

(3.) **Alcohol.**—From alcohol a very large number of useful articles can be obtained, including ether, chloroform, iodoform, chloral, and acetic acid (vinegar). There are many others, but perhaps enough have been mentioned to show the great importance of the starch which is contained not only in potatoes but in all the grains used as food—wheat, barley, oats, rye, rice, and maize.

Manufactures connected with the growing of Wheat, Oats, Barley, and Potatoes.

(1.) Alcoholic Beverages.

Beer.—Barley is moistened, spread out about 3 inches deep on the floor, and the temperature kept constant. The grain begins to sprout, and a substance is formed in the grain which afterwards turns the starch into sugar. The grain is then heated to give flavour to the beer. The dried grain is called malt. The malt is then steeped in water, and malt sugar is formed and run off into large copper pans. The dried flowers of hops are added and give a slightly bitter taste to the liquid. When the liquid is cooled yeast is added, and as there is not sufficient malt sugar in it to give much alcohol, glucose is added and the liquid allowed to ferment.

Wine.—Grape juice, which contains grape sugar, is left in open vats and ferments. Wine is not made commercially in England, but it is possible to produce wine substitutes from alcoholic liquids and imported grape juice.

Spirits (whisky, gin, rum, and brandy).—These are made from barley, but can be made from potatoes. In this case, however, the liquid is distilled, while the flavour is frequently obtained by putting the spirits into casks which have previously had port or sherry in them.

(2.) Flour-Milling.

As by far the greatest part of the wheat consumed in this country comes from abroad, the great flour-milling centres

are at or near the ports. The Thames, the Humber, the Tyne, the Forth, the Clyde, the Mersey, the South Wales coast, and the Bristol Channel receive the grain and convert it into flour. There are of course many small mills still in the interior of the country, but they are very rapidly becoming relics of a past when England's agriculture was used to satisfy local conditions and imported flour and wheat were unimportant.

Cattle Crops.

Cabbage.—The cabbage requires strong soil, while salt air improves it. It is not affected by wet or frosty weather, and grows wild on the cliffs of the south coast, where it is eaten by dairy cattle. It has been known since the earliest times, and was probably one of the first plants to be cultivated in Europe. "Both the turnip and the cabbage must have been factors of considerable weight in the early civilization of Western Europe. We can imagine some old European savage, wandering along the seashore dinnerless, until at length he was pressed by hunger to experiment upon unfamiliar plants. He sees the tall weedy sea-cabbage, and finding nothing more tempting tries its flavour. There is a slight pungency of taste, which raises misgivings, but no ill effect follows. Next day the sea-cabbage is again reverted to, and in time becomes a regular article of food. Presently some ingenious fellow—the Watt of his age—saves himself the trouble of a daily journey to the seashore by transplanting a few cabbages to a patch of ground near his cave. . . . Years, perhaps centuries later, another great advance is accomplished, and men begin to raise the cabbage from seed. It is no longer necessary to spend whole days seeking food, and the man's hands are set free to make himself shoes and a coat and a house." *

Turnips.—Turnips grow well in a damp, dull climate such as that of the north of England and Scotland. A light soil is best for turnips, while swedes thrive well on stiff clays.

* *Round the Year*, by Professor Miall, published by Macmillan and Co.

They are both used as winter food for sheep and cattle. Previous to 1700 most of the land was unfenced, and very little hay was made; thus winter was a period of starvation for cattle. Except those which were kept for breeding, the cattle were killed before winter, and salted. No fresh meat was eaten during winter. There were no fresh vegetables. Thus diseases, the worst of which was leprosy, were caused. It will be easily appreciated what a tremendous revolution in the lives of the people was due to the introduction of the turnip from Holland, the most advanced agricultural land in Europe, about the time of the union of England and Holland under William III. Townshend, on retiring from political life, devoted his time to the cultivation of the turnip, and is said to have increased the productive power of his farm tenfold. With **roots as winter food** cattle-breeding increased enormously, and cattle and sheep soon doubled in weight. Townshend is also credited with having introduced the four-year or Norfolk system of **rotation of crops**—roots, barley, clover, and wheat.

From the introduction of the turnip British agriculture rapidly increased in importance, and during the Napoleonic wars, great food supplies being necessary, common lands and open fields began to be enclosed by hedges and ploughed. Cultivation was carried up to the edge of the moors. Even with this increase in cultivated land, wheat cost between £5 and £6 a quarter. After the wars reaction set in; the large towns needed beef and mutton; agricultural wages were low, while factory wages were high; new supplies of wheat came into the market from overseas. Therefore the amount of permanent grassland increased, the area under wheat diminished, and the bulk of our food grains were imported. At the present time the same conditions operate, even though the Great War caused a great revival of agriculture, and a large proportion of the land is permanently under grass.

Beets—Mangolds and Sugar Beet.

(1.) **Mangold** (mangel wurzel, root of scarcity).—The mangold is more sensitive to frost than the turnip, though it keeps well till the following year. It is therefore chiefly grown in the warmer and drier parts of the British Isles (*i.e.* in the south and east of England, where it is used as food for cattle).

(2.) **Sugar Beet.**—The sugar beet is still more sensitive to frost, and requires a hot, damp summer, followed by a hot and dry August and September, during which months the sugar is stored. Manuring is required during the early growth. Sugar beet is chiefly grown in Central Europe, and, though it has been grown successfully in England on the Welsh border and in East Anglia, there is no sugar beet industry in this country. In Germany the sugar manufacturer has been assisted by a system of Government bounties, which made it possible for the sugar obtained to be sold in Britain at a much cheaper price than the cane sugar which we formerly obtained in large quantities from the West Indies. The beet is crushed and the sugar is separated as juice ; the crushed beet is then used as cattle food. Our sugar supply is largely obtained from Germany, France, and Holland.

Other Cultivated Plants.

Hops require a warm summer, with much sunlight. They have large roots and exhaust the soil. As a result rich, deep, somewhat porous soils are needed for the growth of hops. The highly fossiliferous Greensand formation of Kent, Surrey, and Sussex, and the rich soils of Hereford, Essex, and Hampshire are the chief producing regions of the British Isles. The bulk of the British supply of hops is obtained from the Continent and the U.S.A.

Flax requires a moist firm soil, containing salts which can be easily assimilated by the roots of the flax. The basaltic soils of North-east Ireland are suitable for the cultivation of

flax. In the Middle Ages, in fact till the introduction of cotton, flax was widely grown—*e.g.* in the upland districts of Scotland —and was made into linen where it was grown. Irish linen has been famous since before the Norman Conquest.

The introduction of machinery and the use of imported cotton drove the linen industry into factories situated near the coalfields. This did not seriously interfere with the amount of flax under cultivation. The opening up of trade with the Baltic provinces, where flax was produced much more cheaply than in the United Kingdom, caused a great decrease in the area under flax in the British Isles. Lately, however, there has been an attempt to increase the area under flax—*e.g.* in Ireland growth has increased, while the university of Leeds has undertaken experiments at Selby with the object of inducing the farmers of the Vale of York to reintroduce the crop, which has now been neglected for over twenty years. The fibre is used for the manufacture of linen, the seed is crushed for oil, and the crushed seeds are used for cattle food. The short fibres are used for the manufacture of twine or cord. When the coarse canvas is treated with oil, oilcloth is made.

There are thus two industries connected with flax: (1) The manufacutre of linen, canvas, twine, oilcloth; (2) the crushing of seeds for the manufacture of cattle food (cake), manure, oils, margarine, soap, etc.

The chief source of imported fibre is Russia, while the oil seeds, including cotton seeds, are obtained from India and the U.S.A.

Hemp is an exhausting crop, and is very susceptible to frost. Thus it can only be grown in these islands as a summer crop. It is used for the making of rope, the coarse fibres being used for canvas; the oilcake is used as manure, while the seeds are used as bird food. A large quantity of hemp and rope is imported from Russia, but the best quality of rope comes from Italy and the Philippines. Jute is not grown in Britain, but large quantities are imported from Bengal and manufactured at Dundee.

Fruits.

(1.) **Apples, Pears, Plums, and Cherries.**—As the bottoms of valleys are frequently colder than the hillsides at night (see Fog), fruits are frequently cultivated on the hillsides. Another reason for orchards being on the hillsides is that the drainage is better than in the low-lying situations. The climate should be warm and moist, and free from frost. As a result, fruits are largely grown in the south and south-western counties. Hereford, Cornwall, Devon, and Somerset produce apples and pears, while Surrey and Kent produce plums and cherries.

(2.) **Small Berries.**—Small berries grow best on thin soils, where by starving the plant the flowers and fruits are compelled to form. Thin soils are also found on the hilltops—*e.g.* in the north the long hours of summer sunlight and good drainage give a plenteous crop of small berries.

The Products of the Uncultivated Land.

Moorland is purely grazing country, though the moors with their gorgeous flowers are capable of supporting large numbers of bees. The remainder of the land is grouse moor, deer forest, and bogland. The grouse moor is a barrier to agriculture. As agricultural land the moor would bring in about 9d. an acre rent; as grouse moor it brings in 2s. per acre. The margins of the deer forest are not small holdings as they were formerly. It is a great pity that the moorlands are not utilized for a better purpose than for grouse shooting, as a considerable proportion of them are suitable for afforestation.

Animals.

(1.) **Cattle** are chiefly found in the river valleys. The south coasts and midlands of England, the central plains of Ireland, the valleys of the Eden, Yorkshire Ouse, Dee, Forth,

Tay, and the Aberdeen Dee, produce the greater part of the cattle of the British Isles. As a result, not more than half the British supply of meat comes from the U.S.A., Canada, Argentine, New Zealand, and Australia.

In spite, however, of the large number of British cattle the milk supply of our large towns is inadequate, while in many country places milk is given to the pigs—either because of the lack of facilities for transporting it to market, or because the farmers are too lazy to turn it into butter and cheese. As a result a large part of our supply of butter comes from Denmark, and of cheese from Canada. Eggs are imported from Russia. There is, however, no reason why the British Isles should not be self-supporting so far as dairy produce is concerned.

(2.) **Sheep** are produced in those parts where turnips, mangolds, and permanent grass are grown. It is found that long-fleeced sheep are best suited to the limestone uplands—*e.g.* the Pennines, the Oölitic, and the Chalk escarpments produce great quantities of wool, while the damp mountainous moorlands produce the best mutton (*cf.* Welsh mutton).

(3.) **Pigs** depend on the forests for food. There is little forest left in the British Isles. Thus the pigs have to be raised as by-products of barley, potato, and cattle-producing farms. There are few pigs in Scotland. Grain-fed pigs are raised in the Midlands, Berkshire, Yorkshire, and the central plain of Ireland. The bulk of the supply of imported bacon, pork, and ham comes from the U.S.A.

(4.) **Horses** thrive on well-drained limestone plateaux—*e.g.* draught horses are raised in Cleveland and Ayrshire; racehorses are bred on the Chalk uplands, the Yorkshire wolds, the Lincoln wolds, the East Anglian heights, and the North and South Downs. Hunters, cavalry horses, polo ponies, and mules are obtained from Ireland.

TABLES FROM THE CENSUS OF PRODUCTION, 1907.

	Home Production.	Imported.
Wheat and Flour .	£10.664 millions	£44.483 millions
Oats	£18.140 ,,	£4.563 ,,
Barley	£10.218 ,,	£6.110 ,,
Potatoes	£5.948 ,,	£1.967 ,,
Milk	£29.5 ,,	£1.6 ,,
Butter	£13.0 ,,	£24.0 ,,
Cheese	£1.5 ,,	£6.7 ,,

TABLE SHOWING SHRINKAGE OF CROPS (IN MILLIONS OF ACRES).

	Wheat.	Oats.	Barley.	Potatoes.	Turnips, Mangolds.	Cows.	Cattle.
						Mil.	Mil.
1877 . .	3.321	4.2	2.6	1.4	2.8	3.7	9.7
1887 . .	2.388	4.4	2.2	1.4	2.7	3.9	10.4
1897 . .	1.939	4.2	2.2	1.2	2.6	3.9	11.4
1908 . .	1.664	4.2	1.8	1.2	2.4	4.4	11.7
1912 . .	1.971	4.1	1.8	1.2	2.4	4.4	11.9

AREAS UNDER CROPS (IN 1,000 ACRES).

	England.	Wales.	Scotland.	Ireland.
Wheat	1725	38.0	54.0	43.0
Barley	1383	87.0	191.0	162.0
Oats	1873	203.0	954.0	1051.0
Beans	281	1.2	9.2	1.7
Peas	157	0.66	0.6	0.3
Potatoes	403	27.0	143.0	589.0
Turnips	1051	58.0	440.0	275.0
Mangolds	440	11.0	2.3	76.0
Hay	5748	71.3	586.0	2399.0
Hops	3	..	..	..
Cabbage	148	5.4	13.6	40.0
Small fruits	77	1.1	7.3	14.0
Flax	..	..	..	..
Orchards	248	2.0	..	..
Timber	(1907)		875.0	301.0

AREAS UNDER CULTIVATION (IN 1,000 ACRES).

	Total.	Mountain Grazing.	Grass.	Waste.	Arable.
England	32,564	2,460	13,891	1,720	10,611
Wales	4,778	1,345	2,042	187	733
Scotland	19,462	9,070	1,492	875	3,357
Ireland	20,351	2,558	9,861	300	4,798

COMPARISON OF AGRICULTURAL AREAS.

	Per Cent. of Total.				
	Danish.	Dutch.	Swiss.	French.	Irish.
Arable	42.5	27.7	16.5	52.4	11.1
Hay	28.2	34.7	35.9	11.3	64.1
Forest	4.6	6.9	18.4	18.3	1.5
Vines	..	..	0.8	3.7	..
Waste	24.7	30.7	28.4	14.3	23.3

QUESTIONS AND EXERCISES.

(1.) How is it that—

(*a*) "Less land is under wheat in the British Isles than formerly"?

(*b*) "The United Kingdom is dependent on foreign countries for its supply of sugar"?

(*c*) "English beer is more intoxicating than the light Continental beers"?

(*d*) "The uses of the potato are many and varied"?

(*e*) "Cattle are more important than sheep in Ireland, while sheep are more important than cattle in South-eastern Scotland"?

(*f*) "Compared with Denmark, Britain is in a disgraceful condition with regard to the supply of milk"?

(*g*) "The Broads teem with wild fowl"? and

(*h*) "So much mustard is grown in Lincolnshire"?

(2.) In what parts of the British Isles are (*a*) wheat, (*b*) hops, and (*c*) flax chiefly grown? (*d*) In what parts are cattle mostly found? Give reasons for your answer.

(3.) Why is corn largely grown in the eastern counties of England, and grazing so extensively practised in Ireland? Which are the orchard counties, and where is the Carse of Gowrie? For what is it noted?

(4.) "Wool at one time was the most valuable commercial product of Britain." State where the wool was chiefly produced, and describe the conditions specially favourable to it. Compare the conditions in Britain with those of the wool-producing regions of Australia.

(5.) The counties of Devon and Lincoln are nearly the same size. Compare the following figures and explain the contrasts they show :—

	Arable Land.	Wheat.	Dairy Cattle.	Sheep.	Population per Sq. Ml.
	Acres.	Acres.			
Devon .	515,000	48,000	82,000	914,000	275
Lincoln .	1,006,000	180,000	49,000	1,092,000	214

(6.) Account for the differences revealed by a comparison of the figures in the following table :—

	England.	Scotland.	Ireland.
Areas (in million acres)	32.0	19.0	20.0
Uncultivated Land	8.0	14.0	3.0
Land under Wheat	1.6	0.03	0.05
Land under Oats	2.0	0.84	1.15

(7.) "The English defeated Napoleon on a basis of turnips." What does this statement of Professor Lyde mean?

(8.) Draw an outline map of the British Isles, showing the distribution of plants and animals.

(9.) Draw a sketch map of the district or county in which you live. Show on it the chief cereals grown, and the stock raised in the district.

(10.) If you live in the country, state and explain what you have observed regarding the nature of the soil, the relative amount of arable land and grassland, the crops grown, and other agricultural produce.

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CHAPTER III.

THE TEXTILE INDUSTRIES OF THE UNITED KINGDOM.

THE WOOLLEN INDUSTRY.

THE conditions which must be satisfied for the manufacture of wool are: (1) That coal or water-power necessary for the driving of machinery should be near the place of manufacture; (2) that the atmosphere of the manufacturing district should be damp; (3) that there should be an abundance of raw wool near at hand; (4) that the population should be skilful weavers; and (5) that a sufficient supply of soft water should be available for cleansing the wool.

The Supply of Raw Wool.

In early times the Continental supply of raw wool was largely obtained from this country, but the manufacture of woollen cloth was confined to the Low Countries. The chief export of Britain in the Middle Ages was raw wool. The English wool was of first-class quality. This was, in part, due to the efforts made by the monasteries to improve the quality of English wools by careful cross-breeding. The introduction of Spanish merino stock led to further improvement. The social changes which took place towards the end of the Middle Ages—namely, the shortage of agricultural labour and the system of enclosures—had the effect of enormously increasing the output of British wool. Writing about

the year 1515, More says: "Wherever it is found that sheep of any soil yield a softer and richer wool than ordinary, there the nobility and gentry, and even those holy men the abbots, not contented with the old rents which their farms yielded, nor thinking it enough that they, living at their ease, do no good to the public, resolve to do it hurt instead of good. They stop the course of agriculture, destroying houses and towns, reserving only the churches, and enclose grounds that they may lodge their sheep in them. . . . One shepherd can look after a flock, which will stock an extent of ground that would require many hands if it were to be ploughed and reaped. This likewise in many places raises the price of corn. . . . Luxury likewise breaks in upon you to set forward your poverty and misery; there is an excessive vanity in apparel, and great cost in diet, and that not only in noblemen's families, but even among tradesmen, the farmers themselves, and among all ranks of persons."

Thus, even while protesting against the enclosing of land, More testifies to the increasing wealth of the country. We know that several English kings conducted negotiations with Continental rulers as to whether English wool should be imported into France or into the Low Countries. We must conclude, therefore, that the power of England was largely due to her production of wool fleece. Much later, however, new uninhabited lands were discovered, where it was possible to raise sheep in thousands as easily as in England scores were raised. Thus we find at the present day that a very large proportion of our raw wool supply is derived from Australia, the Cape, and New Zealand, while the Continental supply is largely obtained from South America.

The Growth of the Woollen Industry in Britain.

No doubt woollen cloths were made in very early times by the villagers who owned sheep. The industry was necessarily carried on in the cottages of the peasantry after the day's

work on the farm was over. The word "spinster" has been in the language a long time now, and doubtless the art of making woollen thread and of converting it into rough clothing was part of the common knowledge of the women. In time certain places began to be recognized as producing superior kinds of cloth. Thus, mention is made of the wool of Bristol, Worstead in Norfolk, Salisbury, Lincoln, and Kendal; but in spite of this the English were not nearly as capable as the Flemish in the art of making and dyeing cloth.

The troublous conditions of the Continent, particularly the Low Countries, drove skilled workmen to settle in England. This led to the establishment of a definite weaving industry in England. The beginning of this immigration of skilled workmen commenced in Edward III.'s reign, and each succeeding war in Flanders drove fresh batches to England. By the year 1500 a strong gild of woollen manufacturers was formed—the Merchant Adventurers—which was able to hold its own against the older gild of wool-fleece exporters, the Wool Staplers.

During this period the chief woollen manufacturing towns were in the Eastern Counties and the Bristol district, where the refugees had settled, and where the chalk hills provided abundant pasture for sheep. The great sheep farmers were often great clothiers as well, and gave out raw wool for cottagers to spin and weave at home, so that by the end of the sixteenth century cottages in which there was no spinning-wheel were the exception. This, no doubt, did much to remedy the unemployment which More referred to in speaking of the enclosures.

Till this time the manufacture of cloth had been confined to the river valleys, where there was abundant pasture, and Norwich, York, and Bristol were the chief centres of manufacture; but now a gradual displacement of the industry took place. All three centres had made the same kind of cloth; but the use of water-power in the upland valleys of the Cotswolds and the Pennines allowed the West

Country to specialize in that form of manufacture which required machinery. The East Anglian centres, having no such power, had to be content with making worsteds. The North began to manufacture on a much more extensive scale with the introduction of water-driven machinery, and as a result the industry deserted York, and Norwich lost its pre-eminence. The Pennines possessed much greater water-power than either the West Country or the Eastern Counties. This led to the establishment of a very extensive cottage industry in the little hill valleys of the West Riding. The water running over the sandstones (Millstone Grit) was soft, and thus more suitable for washing than the waters of York, Lincoln, Norwich, and Canterbury.

The greatest change came later, when spinning and weaving machines, driven by steam generated by coal, were invented. As the West Riding had the greatest coal supply, the industry became definitely centred there, and the weaving population left its hillside cottages and concentrated in huge towns on the coalfield. Manchester specialized in the newly introduced cotton, and huge unhealthy factories were erected both in Lancashire and in Yorkshire. Collieries flourished, and very early in the nineteenth century the north and north-west of England, where agriculture could not have supported many persons, was crowded with a teeming population of artisans, miners, and weavers.

Centres of the Woollen Industry.

1.) **The West Riding of Yorkshire.**—The West Riding produces 80 per cent. of the English woollens. **Bradford,** the greatest woollen manufacturing town in the world, produces cloths, serges, blankets, and carpets. This trade is shared by Huddersfield, Halifax, and Keighley. **Leeds** is the greatest clothing town, and specializes in the making of ready-made suits. This industry has attracted a large number of Jewish tailors. Dewsbury and Batley make cloths, but

FIG. 24.—Map of the West Riding Woollen District and the South Yorkshire Coalfield.

specialize in shoddy, a woollen cloth made by fixing particles of wool on to cotton threads which are used to make the cloth.

(2.) **The West Country Woollen District.**—This comprises parts of the counties of Wiltshire, Oxford, Berkshire, and Gloucester. The chief cloths still made are broadcloths, waterproofs, Bedford "cords," and putties. The chief towns are Bradford, Trowbridge, Stroud, Frome, and Westbury, Wilton (carpets) and Witney (blankets). The industry grew up here because of the abundant sheep pastures on the chalk and limestone hills, and the water-power of Gloucester, Somerset, Wiltshire, and Oxford, and is continued because of the nearness of the Bristol, Midlands, and South Wales coalfields. The best fabrics were those requiring water-power. Broadcloths are typical of Gloucester, Wiltshire, and Somerset, with special production of blankets in Witney district: serges are the chief cloths of Somerset and Devon.

Natural Advantages of the West Country.—(1.) The large amount of rich arable and natural pasture lands (sheep) gave a relatively dense population at a time when Yorkshire was almost undeveloped. (2.) The natural port of Bristol, with Irish (long staple) and Mediterranean (short staple) trade, obtained supplies of Spanish merino wool (short) which was afterwards superseded by Silesian and later by Australian wool, and supplies of oil for giving suppleness to the wool were got from Italy. (3.) The relative humidity of the air was high, so that oil was not always necessary. (4.) Local supplies of other raw materials than wool could be obtained; for example, there was a good supply of teasels (the surplus being sent to Yorkshire) and fuller's earth from the Middle Oölitic rocks near Bath. Witney depended on the waters of the Windrush, which were particularly good for scouring blankets; while Glastonbury, in Somerset, owed much to the methods of the French and Walloons who immigrated about 1550.

CLASSIFICATION OF FABRICS.

Water-power required for milling.	(1.) Woollen cloths, fine short wool.	Broadcloths, liveries.	Stroud, Trowbridge, Frome.
	(2.) Mixture of woollen and worsted, short and long.	Cloths and serges.	Devonshire, Wellington.
Water-power not required.	Worsteds, long wool.	Damasks, serges.	Norwich, Sudbury, Alton, Taunton, Tetbury, Cirencester.
A little water-power required for scouring.	(1.) Woollens, short.	Blankets, kerseys.	Witney, Suffolk.
	(2.) Mixture of woollen and worsted.	Baize, flannels, linseys.	Essex, Barnstaple, Salisbury.

(3.) **The Midlands.**—Leicester and Nottingham specialize in woollen hose and in mixed woollen and cotton fabrics. Kidderminster carpets are still famous, though most "Kidderminster" carpets are made in the West Riding. The other carpet towns are Kilmarnock, Axminster, and Ayr.

(4.) **The Tweed.**—The woollen industry of the Tweed owes its existence to the excellent hill pastures, the soft water for washing the wool, and the water-power of the upland streams. The famous twill or "tweed" cloth is made at Hawick, Jedburgh, Galashiels, Dumfries (also hose), the power being obtained from imported coal.

(5.) **The Welsh Wool District.**—Welsh (twills) tweeds and flannels are made at Dolgelly, Montgomery, Newtown, Welshpool, and were formerly sold at Shrewsbury. This district has water-power and pasture, but no coal.

(6.) **Irish Woollens.**—The Irish industry is chiefly a cottage handloom industry. There is very little machinery employed; dyeing is carried on by using wild plants—*e.g.* a lichen called crotal. In Donegal, Mayo, and Kerry homespun cloth fairs are held for the sale of cloth at Ardara and Carrick; for the sale of wool and sheep at Ballinasloe and Bonagher, Tuam,

and Dublin. North Donegal makes a dark and heavy cloth; Castlebar makes a light-coloured heavy cloth; Connemara makes a so-called flannel.

(7.) **The Hebrides.**—A small handloom industry still exists in the Western Hebrides ("Harris" and "Lewis" tweeds).

Cotton Industry.

Conditions of Manufacture.

For the manufacture of cotton the air should be moist, coal or abundant water-power should be found near the place of manufacture, skilled labour should be plentiful, and a supply of raw cotton should be easily obtained.

The Growth of the Cotton Industry.

About 1328 Flemish weavers made their appearance in this country. Some settled in Lancashire, and soon Manchester became known for the manufacture of a kind of woollen cloth known as "Manchester cottons." The numerous rivers and waterfalls in the county contributed to the success of the manufacture.

The true cotton industry had its origin in the East, where the cotton plant is indigenous. The Romans brought the fabric from India, where in many places the same kind of manufacture is carried on. The natives still spin this yarn, web as well as weft, with distaff and spindle; and the loom on which the cloth is woven is composed of a few sticks or reeds placed under the shade of a tamarind or mango tree, with the balance fastened to one of the branches; two loops underneath the gear, in which the weaver inserts his great toes, serve as treadles, and the shuttle, formed like a netting needle but longer than the breadth of the cloth, is used alternatively to draw through the weft and strike it up into the web. The loom has no beam; the warp is laid upon the ground the whole length of the piece of cloth, and upon this primitive

machine are produced those beautiful muslins which are so much admired for their beauty and fineness of texture.

It is not known exactly at what date cotton was introduced into England, but in a work by Lewis Roberts, published in 1641, it is observed that "the town of Manchester buys linen yarn in great quantities, and weaving it, returns the same in linen into Ireland to sell. Neither does her industry rest here; for they buy cotton wool in London, that comes from Cyprus and Smyrna, and work the same into fustians, vermilions, and dimities, which they return to London, where they are sold, and from thence, not seldom, are sent into foreign parts, where the first material may be more easily had for their manufacture." From this time till 1773 the warp was of linen yarn imported from Germany or Ireland, and the weft cotton. At first the weaver supplied himself with both, and sold the finished cloth to the merchant; but about 1740 the Manchester merchants began to supply the weaver with both warp and raw cotton. In this way a system of domestic manufacture was begun over which the head of every family presided, and weaved up the weft which the rest of the family had spun.

Till 1760 the cotton was chiefly used for home consumption, but new markets were being opened in Europe, Asia, and America. The demand became greater than the supply, but as the deficiency was due very largely to the want of weft, unemployment was frequent. The weavers were accustomed to work through the shuttle from hand to hand through the meshes of the web, and when the cloth exceeded 36 inches in width, two men were required at one loom.

In 1735 Kay invented the "fly-shuttle," by means of which a weaver was able to perform twice the quantity of work and to weave cloth of any width. This instrument was first employed in the woollen manufacture, but was afterwards adopted in the weaving of cotton. About this time Highs invented a machine for the spinning of cotton, which he named after his daughter Jenny. This was improved by

Hargreave of Blackburn, and a spinning-jenny was made which would spin thirty threads into yarn. The success of this led to a riot, in which the mob destroyed his machine and drove him into Nottinghamshire. Arkwright obtained a model of High's new machine, the Water-Frame, and perfected it, building mills in Nottingham and Derby, and making a vast fortune. The invention of the carding machine and the mule followed, being used both in the cotton and the woollen factories. The success of the machinery depended very largely on the newly invented steam-engine of Watts, which was introduced in 1787. Cartwright employed the steam-engine in his power-loom, and from that time Lancashire has been the greatest cotton manufacturing centre in the world. The great difficulties were now those connected with the obtaining of raw cotton and exporting the cloth. There were few good roads and no railways, so the construction of canals was begun to carry the rapidly growing trade.

About 1720 Manchester was given the power to improve the navigation of the Mersey by weirs, locks, and canals from above Warrington to Runcorn, so that instead of taking eleven days the navigation took but one day. The Weaver was now made navigable, and the Douglas from Wigan to the Ribble. The Duke of Bridgewater employed Brindley in the making of canals by which coal could be easily distributed. This cheapened the cost of the carriage of coal from Liverpool to Manchester by 50 per cent. Passengers were also carried. Later the Trent and the Mersey were joined by canal; the Leeds and Liverpool Canal was constructed, and Rochdale was joined to Huddersfield. Railways could not do much to cheapen the cost of manufacture, and a few years ago the magnificent Ship Canal was made, giving direct deep-water communication between Manchester and the sea.

The supply of raw cotton comes from the U.S.A. and Egypt; by far the greater part from the U.S.A. Indian cotton is not used to a great extent, because of its relatively poor quality. There are many other places than India where

Fig. 25.—The Cotton-manufacturing Area of the Lancashire-Cheshire Coalfield.

cotton could be grown—Queensland, Natal, British Honduras, British East Africa, Uganda, and parts of the Sudan being in British territory. The trade in cotton goods is very largely in the hands of this country, Germany, and U.S.A., but it is noteworthy that modern factories are being erected in India, where labour is extremely cheap.

Cotton Towns.

Manchester is the most important market, while Salford, which is practically the same town as Manchester, is engaged in making cottons. Manchester, like New York and Leeds, is also occupied in the making of articles of clothing from the cloth. Bolton, Oldham, Blackburn, and Bury are engaged in spinning and weaving, while the chief supply of coal comes from the district round Wigan. Hosiery and lace are made at Nottingham, Derby, Drogheda, and Glasgow, while thread is made at Paisley.

The Silk Industry.

The conditions necessary for the manufacture of silk are a cheap supply of raw silk, soft water, coal or water power, a damp atmosphere, up-to-date machinery, and skilled labour.

In the Middle Ages the supply of silk came across Mesopotamia or through the Isthmus of Suez. This meant that the Mediterranean countries had a great advantage in the manufacture of silk. About the year 1500 the Cape route to India was opened out, and the chief ports of Western Europe were able to obtain the silk trade. In course of time London became the silk market of Europe. In 1685 Louis XIV. revoked the Edict of Nantes. This drove large numbers of Huguenots into England; as a result silk began to be manufactured in Derbyshire and London (Spitalfields). In 1869 the Suez Canal was opened, and the silk manufacture finally returned to the Mediterranean area, where the mulberry could be grown and the silkworm reared. Marseilles is now the greatest silk port, and supplies the factories of the Rhone

Valley (Lyons) and Paris, while Salonica and Barcelona import or produce their own raw material. Silk is still manufactured in England to a small extent, at Derby, Congleton, Leek, Ilkeston, and Macclesfield.

The Leather Industry

The supply of raw materials and coal determines the position of the leather-manufacturing towns. Tanning materials, obtained from the bark of suitable trees or by chemical means, are necessary. As a result, leather goods are made either at the ports which are best suited for the importing of hides or at pastoral centres near the coalfields.

Ports.—London (Bermondsey), Hull, Manchester, Perth, Belfast, Newry, Londonderry, and Coleraine.

Pastoral Centres.—Northampton, Leicester, Leeds, Stafford, Birmingham, Carlisle, and Norwich.

Dyeing.

Dyes for textiles were, previous to the Great War, largely obtained from Germany. The British manufacturer has been indifferent to the progress of scientific research ; the Germans, on the other hand, have tried with great success to reproduce natural dyes from coal distillates. There appears to be no reason why we should not make similar dyes, seeing that Perkin, the discoverer of coal-tar dyes, was British.

Questions and Exercises.

(1.) From what parts of the world does Britain obtain its supplies of (*a*) raw cotton, (*b*) wool fleece, (*c*) hides and skins, and (*d*) raw silk ? Give the chief ports of shipment in each case.

(2.) What geographical conditions have made Bradford, Manchester, and Northampton important ?

(3.) Draw a map of the British Isles, showing the centres of the textile industries.

(4.) "The British Isles as existing to-day are largely a result of the Industrial Revolution." Explain what is meant by this statement.

(5.) Using your atlas, describe briefly the English canal system, and discuss the economic and geographical obstacles to its improvement.

(6.) Describe the cotton district and cotton industry of Lancashire giving some account of the sources of the raw material.

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CHAPTER IV.

TIDES AND FISHERIES.

TIDES.

TIDES are the periodic risings and fallings of the waters of the earth. They are caused by the attraction of the sun and the moon. The tide-forming force depends on the masses of the bodies, and varies inversely as the cube of the distance between them.

If F be the tide-raising force, M the mass of the attracting body, and D the distance between the body and the earth,

$$\text{Then } F \propto \frac{M \,.\, \text{mass of the earth}}{D^3}.$$

The mass of the moon is $\frac{1}{81}$ of that of the earth, that of the sun 324,500 times that of the earth; the moon is 240,000 miles away, the sun 92.8 million miles away,

Then the moon's tide-raising force varies as

$$\frac{\frac{1}{81}}{(240{,}000)^3}$$

and the sun's tide-raising power varies as

$$\frac{324{,}500}{(92.8 \text{ millions})^3}.$$

As a result the ratio of the tide-raising force of the moon to that of the sun is

$$\frac{\dfrac{1}{81\ (240{,}000)^3}}{\dfrac{324{,}500}{(92.8\text{ millions})^3}} = \text{about } 2.2.$$

That is, *because the moon is so much nearer the earth than the sun, its tide-raising power on the earth is more than twice that of the sun.*

Why are simultaneous tides caused on opposite sides of the earth?—The nearest part is attracted most. Thus B is attracted more than A, and therefore the waters of the earth are raised into a tide at B. The point A is attracted more

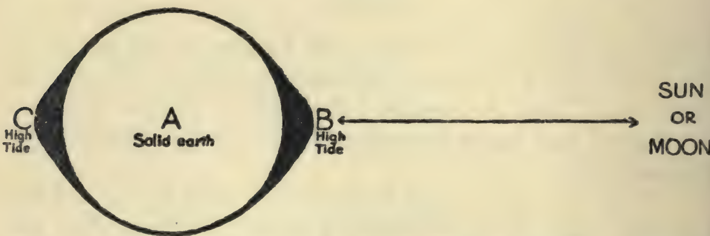


FIG. 26.—Diagram showing the Formation of Tides on Opposite Sides of the Earth.

than C. Thus the solid earth is pulled away from C, and the waters at C are left behind as a tide. In this way tides are formed simultaneously on opposite sides of the earth. The moon revolves round the earth, and this causes the tides to vary.

At New Moon the moon and sun are at the same side of the earth. As a result the moon, which is invisible, and the sun raise one pair of exceptionally high tides—spring tides.

At the first quarter ☽ the sun and moon act at right angles. Thus four tides are formed. In this there can be very little raising of the sea, and there is only a relatively small difference between high water and low water.

At full moon ○ the sun and moon are on opposite sides of the earth. Spring tides are formed.

At the last quarter ☾ the sun and moon are again at right angles to the earth, and neap tides are again formed.

There are two tides each day because the earth rotates. **Why is each tide about twenty-five minutes later than the preceding high tide?** The earth rotates in one day; the moon revolves round the earth in about twenty-eight days. As a result the moon rises about fifty minutes later each day. Thus each tide is about twenty-five minutes later than the preceding tide.

The Effect of Tides on Coast-lines.

Where the speed of the rising tide equals the speed of a river running into the sea, a region of still water is formed, and sand-bars and mud-banks are deposited at the mouth of the river. In the North Sea the set of the tides causes the beach materials to drift into the river mouths. Thus the Tyne mouth was blocked by a sand-bar until it was constantly dredged. The same thing applies to the mouth of the Tees. Sunk Island and Spurn Head have been formed in the same way. The ports of the Wash were of no use except for vessels of very small draught, while the Isle of Thanet has been added to the mainland of Kent, and several of the Cinque Ports are now a considerable distance inland. The mouth of the Thames, and that of the Rhine at Flushing, have high tides, due to the amalgamation of North Sea and Channel tides, though at Helder the two tides almost neutralize each other.

Tides also erode the coast between high and low water levels. Thus, an exceptionally high tide destroyed the promenade at Hornsea; while many towns known as important ports, such as Ravenspur, have been entirely destroyed. The west coasts have much higher tides (Bristol, 30 feet) than the east coasts, and as a result there are fewer sand-bars and mud-banks at the mouths of such rivers as the Severn and those of the west coasts of Scotland and Ireland. An on-

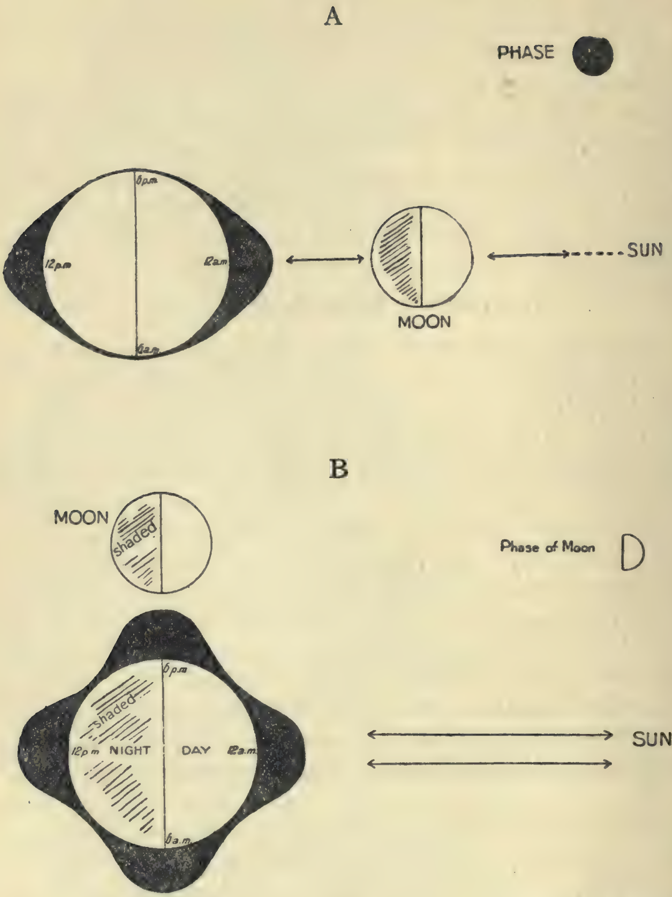
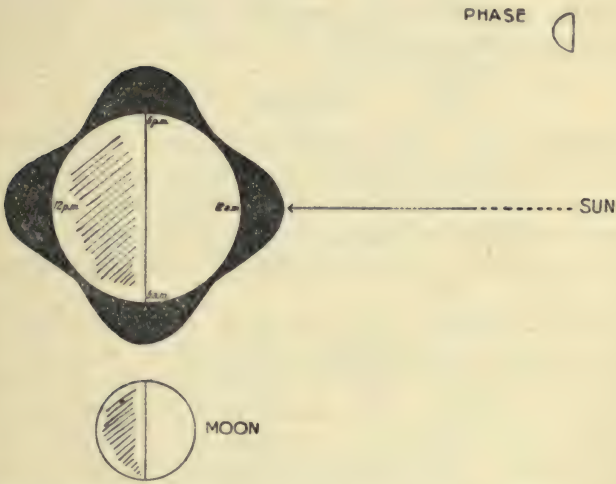


FIG. 27.—Tides and the

A. Spring Tides at New Moon.
B. Neap Tides at First Quarter.

C

D



Phases of the Moon.

C. Spring Tides at Full Moon.
D. Neap Tides at Last Quarter.

shore wind increases the height of the tide (Yarmouth, 12 feet), and an offshore wind decreases the tide (Yarmouth, 3 feet). Where a tide enters a funnel-shaped estuary the water rises as a wall, sometimes 6 feet high, called a **bore** or **eagre.**

FISHERIES.

Fisheries exist (1) where land waste materials are found, (2) where there is shallow water and the light can penetrate, (3) where the sea floor has an undulating sandy bottom, (4) where there is tidal movement, and (5) where there is a junction of waters of different temperatures and saltness. This junction of different waters is a graveyard of the less hardy fish, but a feeding ground for the more hardy species. Thus the North Sea, where relatively fresh cold water from the Arctic Ocean and Baltic Sea meets the warmer salt Atlantic water, is one of the greatest fishing grounds of the world.

Fishing.

Longshore Fisheries.—Shrimping is carried on in Lancashire and on the south-east coasts. Mussels are found in the estuaries, particularly of Lancashire, Wales, and the Forth. Cockles are taken in Morecambe Bay. Oysters are reared in the Wash, on the coasts of Essex and Kent, and along the south coast.

Surface Fisheries.—Fish that shoal on the surface—such as the herring, pilchard, sprat, and mackerel—are taken by a surface or drift net. The nets are buoyed by corks or buoys between the drifters, which steam slowly across the fishery.

Herrings are found from the latitude of Greenland to the Bay of Biscay. They shoal at different seasons at different places, though there is no great migration from one part to another. In spring they are taken from Penzance to Portree and Stornoway; in summer, from the north of Scotland to Hartlepool and Scarborough; and in autumn, as far south as Yarmouth. There is no great market for herrings on the

FIG. 28.—Map of Tides and Fisheries, giving times taken for high tides after first encroaching on the Continental Shelf.

XX and ✱ Compound High Tides of Thames mouth and south-east of the Dogger Bank.

north-east coast of Scotland, so they are cured and re-exported to Germany and Russia.

Sprats are chiefly taken in the Thames estuary, the Irish Sea, the south-east coasts of England, the Moray Firth, the Firth of Forth, the Bay of Biscay, and the mouths of the Norwegian fjords.

Pilchard and **Mackerel** are chiefly obtained from the English Channel and the Irish Sea.

Demersal Fisheries.—Such fish as cod, haddock, plaice, whiting, and soles shoal near the sea floor, and are obtained by trawling. The trawl net is conical in shape, and is dragged near the sea floor. Trawling is the most important method of fishing.

The Modern Fishing Port.

Though it is necessary for the port to be within reasonable distance of the fishing ground, it is far more essential that it should be connected with the great industrial districts by an efficient railway service which enables fresh fish to be sold inland. In the case of those which are at a great distance from the fishing grounds (say the Barentz or White Sea) there must be an ice factory and machinery for loading the long-voyage fishing boats with coal. Each fishing port should have facilities for docking and repairing the fishing fleet.

The chief fishing ports are Grimsby, Hull, London, Yarmouth, West Hartlepool, Leith, Cardiff, and Fleetwood. Grimsby is our greatest fishing port, and keeps a permanent fleet on the Dogger Bank. Coaling and repairing are carried on at sea, while large carrier vessels take the catch to Grimsby and London. Thus Grimsby specializes in the fresh fish trade. Hull, the second fishing port, not only has a permanent fleet on the Dogger Bank, but also sends vessels specially constructed to carry coal and ice on long voyages to Iceland and the Barentz Sea.

The British as a Race of Fishermen.

The isolation of an island causes a definite type of people to develop. The men of the fjords of Norway became the greatest boat-builders and sailors of their day, so that the remains of their boats have been used as models by modern yacht builders. Their descendants, the fisher folk of Britain, inherited their skill in seamanship and boat-building, so that it is natural that the British should be, if not the pioneers (Dutch), one of the greatest shipbuilding and mercantile nations. Since the invention of iron vessels driven by steam our mineral wealth has given us the position of the chief naval and mercantile nation.

Our national characteristics are to a great extent based on our fisher habits. The long voyages of the fisherman at sea meant that the woman was left in supreme charge of the fisherman's home, and had to mend the broken nets, cultivate the little croft, and sell the produce of the voyage. When the man returned tired out, he was not in a fit state to take control of the household, nor was the wife willing to relinquish that control.

That the fisherman's wife is still capable of taking an equal share of the fisherman's work is shown by the modern fisher girl. If one goes to Scarborough or Hartlepool in August, and sees the magnificent Scotch lassies doing heavy work, cleaning and packing the catch brought home by the men, one has no doubts as to their ability to manage things at home while the men are away. As a result, in island fishing communities woman is looked upon as man's equal. Contrast this with the position of woman in Continental regions where the patriarchal system sometimes prevails—*e.g.* the Law of Moses ordains that a woman is a "chattel" (see Tenth Commandment).

The fascination of the sea made the fisherman restless and desirous of seeing fresh lands, so that the sailor was

eventually tempted out on to the oceans, where he met many different races, of different tongues, creeds, and colours, and learnt the most valuable lesson in dealing with foreign nations, that of toleration. Thus it is partly due to the fishing type that we, as a nation, respect women, tolerate almost any point of view, are the greatest lovers of freedom, and possess the greatest mercantile marine and navy in the world.

Questions and Exercises.

(1.) The hours of high and low tide at a seaport, and the difference of level between them, vary from day to day. Give a general account of the changes which take place. Can you connect the changes with the phases of the moon? Explain why there is a difference in the rise and fall of the tides on the same day in the Bristol Channel and the Gulf of Genoa.

(2.) What are tides? How are they caused? How do they vary?

(3.) "The world's greatest fisheries are found on the Continental shelves." Explain and justify this statement.

(4.) Make a map of the British Isles and North Sea countries. Show the fishing ports, the markets for fish, and the routes connecting them.

(5.) What are the conditions which contribute to the success of a modern fishing port? Illustrate by examples.

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CHAPTER V.

THE MINERALS OF GREAT BRITAIN.

CLASSES OF ROCKS.

(1.) **Igneous Rocks.**—Crystalline rocks which have once been melted by great heat, but which have cooled and become solid.

(2.) **Sedimentary Rocks.**—Rocks which have been deposited from (i.) suspension in water—*e.g.* slates, limestones, sandstones, and clays; or (ii.) solution—*e.g.* salt and gypsum.

INDEX TO THE SKETCH MAP OF THE ROCKS.

The map given is very rough and only very approximately accurate, while many important rocks are not shown. It is necessary for any one using this map and the index to refer constantly to an accurate geological map to get the exact position of the various rocks.

(10.) **Old and Igneous Rocks.**—These, generally speaking, are hard, and often unfertile and sparsely populated. The minerals found in them include:

(i.) Slates (Silurian), which are quarried in North Wales, the Northern Highlands, and the south-east of Ireland.

(ii.) Granite, found in many parts of the United Kingdom. It is the volcanic material which forms the stumps of ancient volcanoes. Its numerous crystals are due to the slow cooling of the molten material in the necks of the volcanoes. A geological map shows where granite is found. It is obtained for ornamental and building purposes from the south-east of Ireland, Galway, Donegal, and Aberdeen. It is broken up by the agents of denudation, and in Cornwall and Devon has been so finely broken up that many of the river banks are covered with a finely divided white clay—kaolin or china clay—which is used for the manufacture of fine pottery.

(iii.) Basalt, a volcanic rock, is the ancient lava of Ulster (Giant's Causeway), Mull (Fingal's Cave, Staffa), the Campsie Fells, the Ochil Hills,

the Cheviots, and South-east Ireland. Dykes and sills of this rock are found radiating from the ancient volcanic centres—*e.g.* the Whin Dyke of Durham and Cleveland Dyke near Whitby both originated in the Lake District. It is used for road-making.

(iv.) Marble has been formed where limestones have been partly or wholly melted by molten rock, and is obtained for ornamental purposes from North-west Mayo, South-east Ireland, Donegal, and the Peak district. Most of the old and many of the volcanic rocks are hard and worn down into soil with difficulty, but several are comparatively easily worn into fertile soils, so that the soils of several river valleys in the volcanic regions of Wales and Scotland are fertile.

FIG. 29.—Outline Map of the Rock Systems.

(9.) **Mountain (Carboniferous) Limestone.**—Except where the soil is very thin or non-existent, the mountain limestone is covered with a short sweet grass on which it is possible to raise sheep (the Pennines) and horses (Ireland). Lead and zinc ores are found in cracks in the limestone in Durham, Cumberland, Westmorland, and North-west Yorkshire. In the Furness district valuable deposits of iron ore are found. The numerous lakes of Central Ireland appear to be due to the dissolving of this rock in water containing carbonic acid gas.

(8.) **Millstone Grit or Farewell Rock.**—This is a hard sandstone, probably

laid down as a delta deposit at the mouth of a river coming from the direction of Norway, before the vegetation which afterwards became coal grew. As it is beneath the coal it shows the miner when the coal is ended, hence "Farewell Rock." The early inhabitants of the Pennines used it as a millstone in their primitive cornmills. At the present time it is used for grindstones. Sheffield partly owes its importance to the millstone grit near it.

(7.) **Coal Measures** are alternate layers of coal, sandstone, and shale. The importance of coal is fully realized by every one; coal is the great source of energy for our manufactures.

(6.) **Magnesian Limestone.**—This is found above the Coal Measures. It is used in iron smelting, and its soil not merely forms good pasture land but can frequently be ploughed.

(5.) **Trias.**—There are several different rock systems included in the sketch map under this number, the chief being the Triassic or New Red Sandstones. These rocks are soft, easily form soil, and are therefore fertile. They contain salt, which is pumped out in the form of brine at Greatham in South-east Durham (Cerebos salt), in Cheshire, and round Droitwich in Worcester. Water cannot dissolve sandstone. Thus water from sandstone rocks is frequently used in the textile industries and in brewing; where the soil is marshy, cattle can be reared in large numbers, as in the Midlands.

(4) **Jurassic Rocks, Lias, Oölite,** laid down in estuaries. The Lias consists of layers of clay and limestone. In Cleveland the Middle Lias contains ironstone, and from this formation the bulk of the English iron ore is mined. In Oxford the Liassic clays form a soil suitable for the growth of root crops and wheat. The Oölite is a hard yellow limestone with layers of clay and shale, and forms the ridge followed by the Yorkshire moors, the Lincoln heights, the Northampton uplands, Edgehill, the Coteswold Hills, and finishing in Portland Bill. It supports sheep in Yorkshire, cattle, horses, and sheep in Northampton, and is used as a building stone at Bath and elsewhere.

(3.) **Greensand and Gault.**—These are fertile soils, especially where mixed with limestone fragments from the Oölitic and Chalk hills. In Kent the large number of fossils in the Greensand formation causes the soil formed to be extremely fertile and, therefore, suitable for the cultivation of a crop as exhausting as hops.

(2.) **Chalk.**—Hard white limestone in the north, softer in the south and in France. The Chalk is found in a series of uplands from Flamborough Head, through the Yorkshire wolds, the Lincoln wolds, the East Anglian heights, the Chiltern and White Horse Hills, the North and the South Downs, being continued in the Chalk regions of France. These uplands support sheep, and are extremely suitable for the breeding and training of horses, particularly racehorses. Mixed with the clays of the valleys below, the Chalk forms a rich soil suitable for the raising of root and grain crops. Beech trees grow well on the slopes of the Chilterns.

(1.) **Alluvium and Recent Deposits (Tertiary).**—Soft and fertile. The soils of the valleys and of South-east England form the best wheat-land, and are largely devoted to grains, roots, hay, and seed crops.

It must not be forgotten that, especially in the north, many of the harder unfertile rocks are covered with boulder clay left during the Ice Age, and that crops can be grown on them that would otherwise be impossible to cultivate—*e.g.* at an altitude of over 700 feet it is possible to find grain growing on boulder clay between Newcastle and Durham, though the underlying rock is relatively unfertile.

The south-eastern counties of England are called the Scarplands. An escarpment is the denuded edge of an uptilted stratum of more resisting rock, the underlying layer of rock being less resistant, and as a result more easily worn away. As the layers of rock slope as a whole downwards to

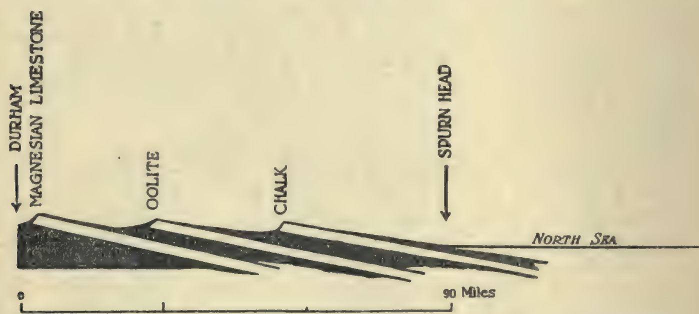

FIG. 30.—Section from Durham to Spurn Head illustrating Scarplands.

the south-east, the escarpments of England usually face the north-west.

MINERALS.

(1.) **Tin Ore.**—Tin has been obtained from the south-west peninsula since the days of the Phœnicians. The Galician tin mines did not produce sufficient tin for the peoples of the Mediterranean, so it became necessary for them to trade with Cornwall—Mount's Bay. As a result the British Islands were known as the *Cassiterides*, or Tin Islands.

Tin is obtained from veins in the volcanic rocks of Cornwall and the Black Forest by mining. The chief source, however, is the Malay Peninsula, where the tin is obtained by directing

jets of water on soils containing tin ore, thus separating the heavier tin from the earth with which it is mixed.

(2.) **Lead Ore.**—Herodotus, the Greek historian, describes the separation of silver from lead ore in England. Ingots of lead and silver dating from Roman times have been found. Lead ore always carries silver, and silver is still extracted by the Pattinson process in Cumberland. Lead is still obtained from the mountain limestone districts of Cumberland, Nor-

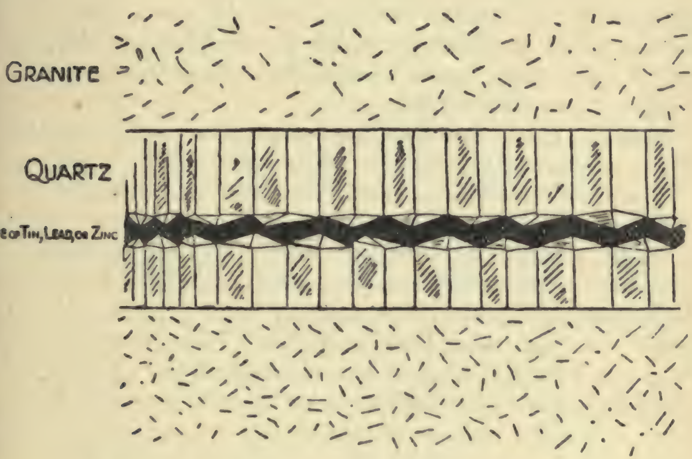

FIG. 31.—Section of a Mineral Vein. The ore forms the core of the vein (black).

thumberland, Durham, Derby, and North-west Yorkshire, but only to a small extent. Our supply of lead is chiefly obtained from the U.S.A. and Spain.

Barium carbonate or witherite, and barium sulphate or baryta spar, are obtained from the old mines. Fluorspar, calcium fluoride, used as a flux in metallurgy, is also extremely common in the lead-mining district of the Pennines.

(3.) **Copper Ore** in the form of pyrites (sulphide) and malachite (basic carbonate) is found in small quantities in

Cornwall, Durham, and Yorkshire, but since the opening of the Montana and Superior mines in the U.S.A. it has not been mined.

(4.) **Iron Ore** was formerly obtained entirely from the lower Coal Measures of the Clyde valley, the Midlands (Stafford), the West Riding, South Wales, Derby, and Shropshire. The Scottish ore contained sufficient carbonaceous material for the ore to be calcined without the addition of fuel.

The chief supply of iron ore in England is obtained from the Lias of Cleveland, Lincoln, Leicester, and Gloucester. Formerly iron ore was obtained from the Weald, but lack of fuel has put an end to smelting in the south-eastern counties.

Lower Lias—Frodingham.

Middle Lias—Middlesbrough, Caythorne, Lincolnshire, Holwell, Leicestershire, and Adderbury in Oxford.

Lower Oölite—Yorks, Lincs, Northants, and Rutland.

Chalk—Weald, and Claxby in North Lincolnshire.

Iron ore is also obtained from the Furness district from the mountain or Carboniferous limestone. (*a*) Red iron ore—haematite; (*b*) brown ore—limonite, both in pockets and in veins, with zinc and lead sulphides. These ores are also obtained in the Forest of Dean, South Wales, Lancashire, Cumberland, and Northumberland, free from phosphorus.

INDUSTRIES DEPENDENT ON MINING.

THE IRON INDUSTRY.

Smelting.—Coal, limestone, navigable water, and a supply of iron ore are necessary for the making of iron. As a general rule it does not pay to manufacture iron inland, because of the high cost of railway transport. Therefore coke is made from coal at the pithead and is sent to the place on the coast where the iron is landed. The limestone which is necessary as a flux is also sent to the port where the iron is smelted.

(1.) **The Manufacture of Coke.**—In the old "beehive" method of making coke all the gas driven off when the coal is heated is lost. In the new "by-product" oven a large proportion of the materials formerly driven off is recovered. The gases driven off contain tar, ammonia, benzol, and waste gas. The tar is recovered, and forms the basis of the coal-tar dyes and certain high explosives; the ammonia is generally passed into sulphuric acid, and the resulting ammonium sulphate is sold as manure; the benzol is purified and used as motor spirit, though benzol products can be made into dyes, explosives, and substances used in medical work; and the waste gases are used for the generation of electricity. Coke is used in the iron furnace because it is harder than coal, and does not contain the sulphur contained in coal. It is produced on a large scale in Mid-Durham, Cumberland, and South Wales.

(2.) **The Smelting of Iron.**—The iron ore is first roasted to get rid of sulphur. It is then mixed with coke, and introduced with a suitable material for forming slag at the top of the blast furnace. Ores which contain lime or magnesia are mixed with sand or clay-slate, those containing silica and clay with limestone, so that an easily melted compound may be formed and removed as slag. Heated air is blown in through the bottom of the furnace and escapes at the top, when it is used again to heat the blast or to drive gas-engines. The molten iron, being heavier, collects below the slag, and is run off into moulds in a bed of sand. The bars of iron made in this way are known as "pigs"—hence pig iron. Pig iron is impure, containing phosphorus, sulphur, and excess carbon. The slags sometimes contain superphosphates. In this case the slag is powdered and used as manure—basic slag.

(3.) **The Making of Steel.**—To make steel it is necessary to free the iron from phosphorus and sulphur. Until a method of doing so was discovered poor grades of iron ore could not be used in the manufacture of steel. Since the method has been discovered the U.S.A. and Germany have seized the

leading positions among the steel-producing countries of the world. Before the Great War steel was largely made by the Bessemer process, in which the molten cast iron is poured into a converter and a blast of air is blown through it. This causes

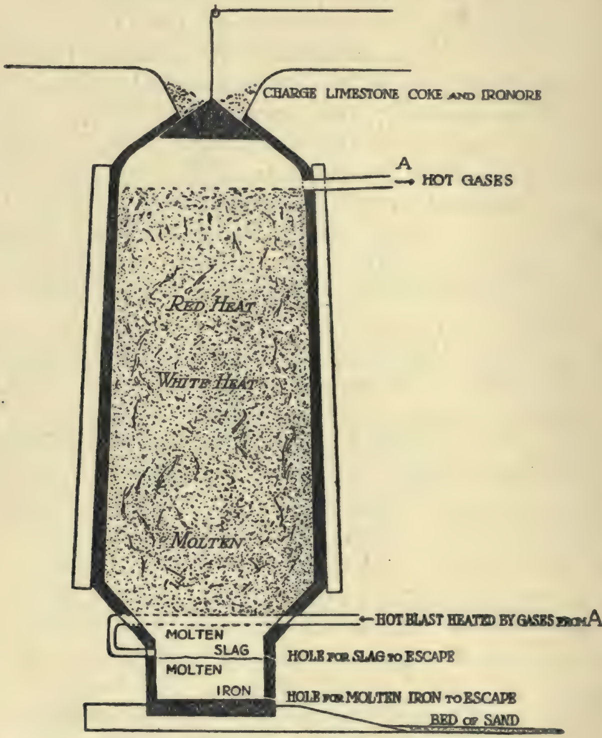

Fig. 32.—Diagram of a Blast Furnace.

the carbon, phosphorus, and sulphur to be oxidized. The phosphorus is removed by lining the converter with a layer containing lime and magnesia, so that the phosphorus is converted into basic calcium phosphate, which is removed before the steel by turning the converter. This process was discov-

ered by Gilchrist and Thomas, and the basic slag pulverized, used as manure, is called Thomas-slag. Manganese iron ore is necessary for the production of ferro-manganese, which in turn is used to make very hard steels. Over 90 per cent. of German steel, over 50 per cent. of U.S.A. steel, but only 40 per cent. of British steel was made by the Basic Bessemer process.

Bessemer steel can be made very rapidly, but as slight differences in the composition of steel make great differences in its physical properties, it was found necessary to use the slower but more exact Open Hearth Process. This consists of heating a mixture of pig iron which contains carbon with wrought iron in a saucer-shaped bed. Iron containing no carbon is added until the molten steel has the required composition. The heating continues about ten hours, and samples are withdrawn and analyzed until a steel of the desired composition is obtained.

(4.) **The Manufacture of Iron Goods.**—The kind of iron goods manufactured depends very largely on the nearness of a place to the sea. Thus the Clyde and the north-east coast specialize in shipbuilding, the making of machinery, engines, and bridges. On the north-east coast Middlesbrough, Jarrow, Consett, Stillington, and West Hartlepool manufacture iron and steel. Bolcknow, Vaughan and Co.'s works were erected on the Tees mouth about 1850 so that foreign ore could easily be imported and the waste materials got rid of. Now Middlesbrough has over sixty furnaces at work, and is the greatest iron-smelting town. Part of the steel (one-fourth) is sent to Sheffield, while much is sent to the Tyne. The Tyne ports, South Shields, Sunderland, and Hartlepool, build ships ; Stockton and Middlesbrough manufacture machinery ; Darlington builds railway engines and bridges. It is entirely the opposite in the Midlands, where the distance from the sea makes transport expensive. Instead of heavy iron goods, delicate machinery and small articles requiring skilled workmanship—*i.e.* articles not bulky in comparison with their cost—

such as needles, pens, jewellery, cycles, small-arms, and chains are made. The only heavy articles made are expensive and delicate machines, railway engines, and motor-cars.

Chemical Industries.

(1.) The Manufacture of Mineral Acids and Soda.

The substances necessary for the manufacture of acids and alkalis are iron pyrites, or raw sulphur, salt, and coal.

Sulphuric Acid.—(*a*) This is largely made by the *Contact Process* (Kneitsch, 1901). In essence it consists of burning raw sulphur in air or in roasting iron pyrites.

$$S + O_2 = SO_2 \text{ sulphur dioxide.}$$
$$4FeS_2 + 11O_2 = 2Fe_2O_3 + 8SO_2.$$

The resulting gas, sulphur dioxide, is then passed with oxygen over a mixture of broken glass, porcelain, and finely divided platinum. The temperature is kept constant at 400° C.

$$2SO_2 + O_2 = 2SO_3 \text{ sulphur trioxide.}$$

The sulphur trioxide is then passed into water and becomes sulphuric acid, the strength of which is kept constant by a regulated flow of water.

$$SO_3 + H_2O = H_2SO_4 \text{ sulphuric acid.}$$

(*b*) The *Chamber Process* is still used for the manufacture of sulphuric acid. Nitric acid is prepared by acting on saltpetre with sulphuric acid. The gas from the nitric acid chamber mixed with air (oxygen), sulphur dioxide, and a jet of steam is then cooled in leaden chambers. As a result an acid of 93 per cent. strength is formed.

Soda (Sodium Carbonate).—Till about 1800 the only source of soda was seaweed, which was heated. It was ten times dearer then than it was before the Great War, so that glass and soap were proportionately dearer than at present. In 1791 the French Academy offered a prize for a cheap method of making soda, and Leblanc invented the method which bears his name.

Unfortunately for him the revolutionaries were cut off from supplies of saltpetre, so his patents became public property, and Leblanc committed suicide.

(*a*) Salt is heated with sulphuric acid.

$$NaCl + H_2SO_4 = NaHSO_4 + HCl \text{ (hydrochloric acid).}$$

The resulting substances are sodium bi-sulphate and hydrochloric acid gas, which is passed into water and becomes hydrochloric acid solution.

(*b*) The sodium hydrogen (or bi-) sulphate is heated with fresh salt and becomes sodium sulphate (salt cake), and more hydrochloric acid is produced.

$$NaHSO_4 + NaCl = Na_2SO_4 + HCl.$$

(*c*) Sodium sulphate is then heated with finely divided coal. Sodium sulphide is formed, and is heated with powdered limestone.

$$Na_2SO_4 + 2C = Na_2S + 2CO_2$$

$$Na_2S + CaCO_3 = \underset{\text{Soda.}}{Na_2CO_3} + CaS \text{ calcium sulphide.}$$

The soda is extracted by treating the ash with water. The soda is soluble, the calcium sulphide is not. The soda solution is then evaporated, and crystals of washing soda are formed. The sulphur in the calcium sulphide is then recovered by treatment with carbon dioxide.

$$2CaS + CO_2 + H_2O = \underset{\text{Calcium hydrogen sulphide.}}{Ca(SH)_2} + CaCO_3$$

$$Ca(SH)_2 + CO_2 + H_2O = CaCO_3 + \underset{\text{Hydrogen sulphide.}}{2H_2S}$$

The hydrogen sulphide is used by burning the hydrogen sulphide in a limited supply of air.

$$2H_2S + O_2 = 2H_2O + 2S.$$

About 70,000 tons of sulphur are recovered in this way annually.

The Leblanc process, however, is not the cheapest and best method of producing soda. It is still carried on in order to produce hydrochloric acid, bleaching powder, impure caustic soda, and sulphur.

The Ammonia Soda Process of Producing Soda.—A solution of salt containing ammonia is treated with carbon dioxide. As a result a much purer sodium carbonate is formed.

Soda is used in the manufacture of alkalis, glass, and soap, and forms the base from which numerous valuable chemicals are made.

Centres of the Chemical Industries.—The salt of Cheshire, South-east Durham, and Dunbar is used in the chemical works of St. Helens, Newcastle, Glasgow, London, and Birmingham.

(2.) Industries connected with Animal Fats and Vegetable Oils.

Not nearly sufficient vegetable oils and animal fats are produced in this country for an extensive manufacture of soaps, glycerine, margarine, and manure. As a result very large quantities of oils, seeds, and animal fats have to be imported—olive oil from Spain, coco-nut from West Africa, linseed and rape seed from India, cotton-seed from the U.S.A.

(*a*) **The Manufacture of Soap.**—Beef and mutton tallow, olive, palm, and cotton-seed oil are heated with caustic soda. Salt is added, and causes the soap to settle on the surface. The residual liquid is drawn off, and from it glycerol is obtained. For soft soaps linseed and rape seed oils are used with caustic potash.

(*b*) **The Manufacture of Nitro-Glycerine and Dynamite.**—When nitric acid and glycerol are mixed nitro-glycerine is formed. As it is difficult to handle, it is run into a fine sand called "kieselguhr." This is kneaded and is then dynamite. Gun-cotton is made from cotton and nitric acid. Cordite is made by mixing nitro-glycerine and gun-cotton into a pulp

with acetone, vaseline being added. Because of their dangerous nature the compounds of nitro-glycerine are generally made in out-of-the-way places, such as Arklow in the south-east of Ireland. During the Great War explosives were made in many other places.

(*c*) **The Manufacture of Cattle Foods and Manures.**—The cotton-seeds, linseeds, rape seeds, and soya beans are crushed and their oils extracted. The crushed seeds are used in the form of cattle cake or manure ; the oils are used in the manufacture of soaps and scents.

(*d*) **The Manufacture of Margarine.**—Beef tallow or suet is heated to a temperature of 35° C., and subjected to pressure. The melted substance is mixed with cotton-seed oil, and sometimes a little milk and butter. This is margarine, and is perfectly wholesome if properly made. Most of the British margarine used to come from Germany through Holland.

Centres of the Soap, Dyes, and Explosives Industries.—Birkenhead (Sunlight), and Liverpool, Selby (Watson's), Manchester, London, Newcastle, Leeds, Birmingham, St. Helens, and Glasgow make soap ; Newcastle and Birmingham explosives ; Perth, Leeds, and Dumbarton dyes. Margarine is made in Cheshire.

(3.) Tin-plating.

Tinplate consists of sheet iron covered with a thin coating of tin. Coal and palm oil are also necessary. The tin was formerly obtained from Cornwall, but the bulk of the supply is now obtained from the East Indies. Palm oil imported from West Africa is used to make the tin adhere to the iron plate. The sheet iron is dipped first into the palm oil to remove particles of air and then into molten tin. The chief centres of tin-plating are in South-Wales—*e.g.* Swansea.

(4.) Glass-making.

The manufacture of glass requires a supply of suitable sand and coal. Navigable water near at hand for obtaining

raw materials and distributing the produce is an advantage. Suitable sand is found on the south coast of England, in Yorkshire, Durham, and Cheshire. Glassworks are found at Newcastle, Sunderland, Castleford, and St. Helens. The making of fine grades of infusible glass and coloured glass depends on the possession of rare earths, and expert knowledge of the chemistry of glass. These were possessed by the Germans, who as a result monopolized the glass trade.

(5.) Earthenware and Pottery Industry.

By the action of water and carbon dioxide on granite and other rocks containing potassium aluminium silicate ($KAlSi_3O_8$), the potash is slowly removed and kaolin or china clay remains. Because clay is plastic when moist, and hard when heated, it is used to make bricks, pottery, and porcelain. The porcelain is generally made from china clay. Salt is used to glaze earthenware vessels to make them watertight. As a result the pottery industry is carried on in North Staffordshire, where coal, salt, and navigable water are found close at hand. Derby and Worcester also have a considerable pottery industry.

(6.) Firebricks.

If a plant is placed in a flower-pot it is found after a time that, in spite of watering, the plant droops. The reason for this is that the soluble salts in the soil have been exhausted. For this reason the soils on which the vegetation which is now coal grew are often almost free from mineral salts. When heated strongly these salts cause soil to melt. Therefore soils containing salts are generally unsuitable for making bricks for furnaces. The soils used for firebricks are accordingly obtained from the Coal Measures. Thus firebricks are made from the saltless soils of the fireclays found in the coal mines—*e.g.* Stourbridge in the Midlands, and Tudhoe in Durham.

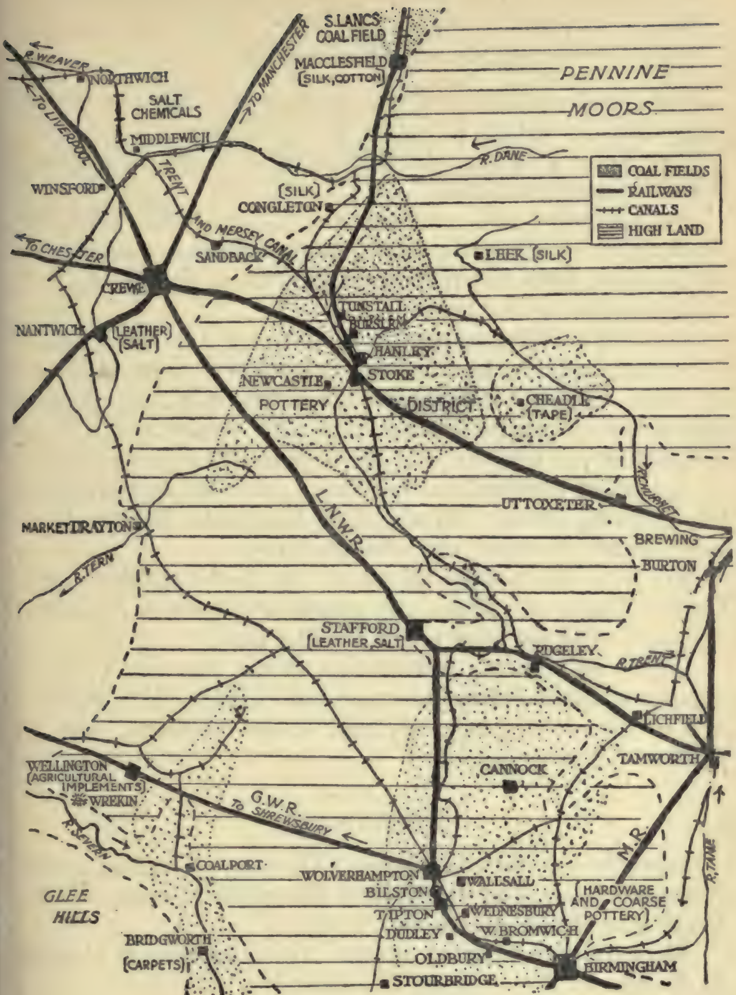

FIG. 33.—Sketch Map of the Potteries

Questions and Exercises.

(1.) What reasons have you for believing that the British Isles were at one time joined to the Continent?

(2.) Make a map of the British Isles, showing the distribution of useful minerals.

(3.) Compare and contrast the Clyde basin with the Birmingham and Staffordshire industrial areas as regards (*a*) products, both natural and manufactured, and (*b*) the outlets for manufactured goods.

(4.) What circumstances have favoured the development on a large scale of the following industries at certain centres in Great Britain: Glass-making, earthenware and pottery manufacture, tinplate-making, and soap industries? Name the centres you refer to, with the important towns in them.

(5.) What geographical conditions have led to the rise of the following towns: Birmingham, Newcastle, Barrow, Glasgow, Cardiff, Sheffield, and Stoke-on-Trent?

(6.) Give the position of six of the chief coalfields of the United Kingdom. Name the principal industries connected with each, and the large towns situated on it.

(7.) Show how the distribution of the iron and steel industries of Great Britain has been influenced by (*a*) the situation of the ore supplies; (*b*) that of the coalfields; and (*c*) facilities for water transport.

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CHAPTER VI.

THE DISTRIBUTION OF POPULATION.

THE two greatest factors which determine the distribution of population are the supply of water and food and of fuel available. Thus the most densely populated regions are those of greatest natural fertility (*e.g.* the monsoon deltas and flood plains) and the coalfields. In the days before food could be easily transported the mass of the population had to live in the richest agricultural districts. The most important centres of population were the market towns of South-eastern England, while the north and west of England was very scantily peopled. The population was fairly evenly distributed outside the market towns in these agricultural districts. At the present time food supply is very largely a matter of transport, and the people overcrowd the coalfields and the districts where mineral wealth is found.

The imported foodstuffs from America, Europe, and our colonial possessions are cheaper than the foodstuffs we produce at home. As a result the wages of agricultural labour are lower than those obtained in the factories, and during the last century workers have deserted the farm for the factory.

FACTORS WHICH INFLUENCE THE SITUATIONS OF TOWNS.

(I.) **A town should have a healthy situation and must have a good water supply.**—For example, London was confined to the gravel districts until a method was found of draining the

clay areas and a supply of pure water was obtained by the construction of the New River. Liverpool has been compelled to construct a great reservoir at Lake Vyrnwy, in Wales; Manchester obtains its water from Lake Thirlmere; while the large towns of Yorkshire and Durham have had to make artificial lakes in the upper valleys of the Wharfe and Wear.

(2.) **The situation of a town often depends on the command of trade routes.**

(*a*) Passes command trade routes, and account for the existence of such towns as Stirling and the castle towns of Britain.

(*b*) Where a tributary joins a main stream a situation strategically strong is the result. For example, York was chosen as a Roman fort because it is situated at the junction of the Foss and the Ouse. Curiously, the capital of the Brigantes, whom the Romans had conquered, was at Isurium (modern Boroughbridge), at the confluence of the Swale and the Ure. Similarly, Hull became important because of the confluence of the river Hull with the Humber.

(*c*) Towns arise between lakes—*e.g.* Enniskillen, Keswick, Interlaken, Detroit, and Buffalo. There are few lakes in the British Isles, but in such countries as Sweden, Finland, Central Africa, and North America many land routes are dominated by such towns.

(*d*) The ends of lakes and arms of the sea are places where trade routes frequently cross—*e.g.* Athens and Chicago.

(*e*) An island in a river is a suitable place for bridging a river. Thus Paris and Montreal were predestined to become towns of importance.

(*f*) Places where rivers could be forded or where bridges were constructed were likely to become centres for the trade across or along the stream. Thus London Bridge became the centre for trade north and south of the Lower Thames, and as ocean-going ships could not pass beneath the bridge, the east of London became a great port for the unloading of foreign goods, and the exporting of foreign goods and the exporting of home produce. A ford constructed across the

Ouse at York similarly became the centre of trade in the Ouse valley, and the west bank was accordingly chosen by the Danes for their trading centre, and the city as the capital of the Danelagh.

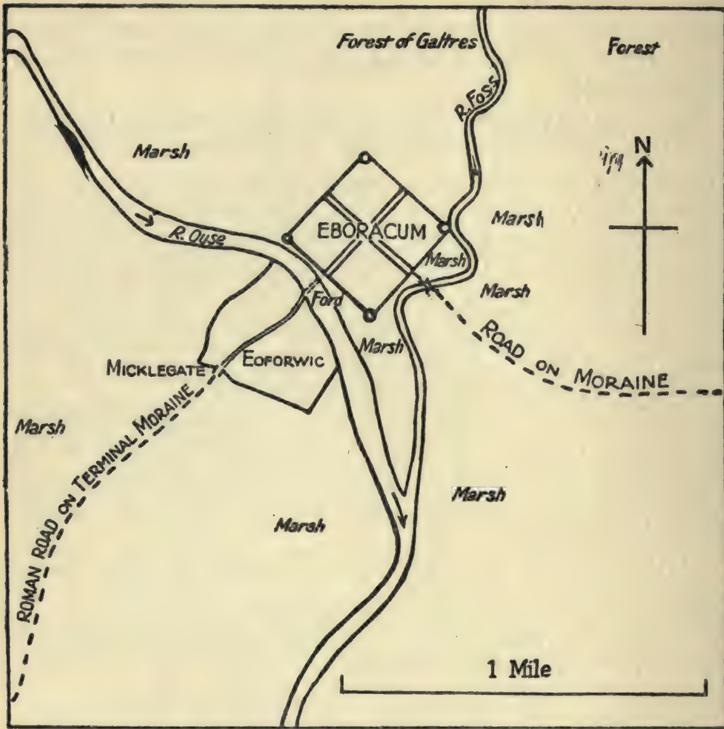

FIG. 34.—Diagram showing the site of York (Eoforwic).

(*g*) Good natural harbours of the drowned valley and fiord types become ports if the interior is important. If the interior is not, the harbour will not become an important town. Thus Galway, on one of the finest harbours in the British Isles, has a population of only 13,000. Southampton Water is an

excellent harbour of the drowned valley type, and has an average depth of 30 feet at low spring tides, thus enabling the largest type of ocean-going vessel to enter it.

The increase in size of ocean-going vessels has caused the growth of outports and artificial docks near the mouths of estuaries: *e.g.* Yarm, being the lowest bridge town on the Tees, was formerly its chief port, but the erection of a bridge at Stockton destroyed its importance. With the increased

FIG. 35.—Diagram of the Lower Tees, showing the bridge towns.

size of ships came the erection of great docks at Middlesbrough, which has, as a result, surpassed Stockton in importance.

(*h*) Railways, especially where competing lines cross, attract population. The growth of towns along railways is best shown by the "mushroom" towns of North America, where the great transcontinental lines have led directly to the establishment of hundreds of towns. The effect of competing lines crossing is shown by the cheapening of freightage charges by

the ordinary process of competition: *e.g.* (i.) It is possible to obtain goods more cheaply from Birmingham and London than from towns served by a single line of railway. (ii.) The people of Hull believed that they were being charged extortionately for the carriage of goods by rail from the West Riding. They built a railway—the Hull and Barnsley—and as a result the cost of carriage between the East and West Ridings fell.

(3.) **Towns grow up near rich beds of minerals, particularly coal.** The most densely populated districts outside London are the coalfields, where the power to be obtained from coal attracts the manufacture of textiles and metal goods.

(4.) **Market towns grow up in the centre or at the outlet of rich agricultural or pastoral regions,** while at the border of manufacturing and agricultural districts towns arise where manufactured goods are exchanged for foodstuffs.

(5.) The **climate** influences the industry which can be carried on at a place. Thus milling is carried on in dry places, spinning in damp ones, while bracing air, as much as mineral springs, causes health resorts to spring up.

(6.) **The possession of waterfalls** gives cheap power, which can be used to generate electricity for manufacturing, lighting, and traction. Unfortunately, Britain does not possess a large amount of this kind of energy, and as a result the bulk of the population is compelled to overcrowd the coalfields, frequently to the detriment of the general health. The type of town caused by the proximity of a large waterfall is quite different from the smoky industrial town we know. The electrical energy can be transmitted long distances. Consequently there is no need for overcrowding in slum tenements. The atmosphere is not polluted to the same extent. Thus life is cleaner and healthier. There is no town in the British Isles which owes its present greatness to its nearness to a waterfall, though in the past the rapidly flowing streams of the Pennines and Central Wales were the only source of power for the textile-producing districts near them, and

Hawick owes its prominence as a manufacturing town to its superior water-power. Aluminium is manufactured by using the electrical power obtained from the Fall of Foyers in Scotland and from similar falls in North Wales (*cf.* bauxite electrolysis method of obtaining aluminium).

COALFIELDS AND POPULATION, 1911.

Coalfield.	Imported Iron from—	Pop. per Sq. Mile.	Industries.	Chief Towns.
South Wales.	Spain.	Over 1000.	Coal export, iron, copper, tinplate.	Cardiff, Swansea, MerthyrTydfil.
SouthYorkshire. Derby.	Cleveland, Lincoln. Leicester, Stafford.	Over 1000.	Wool & steel. Lace and silk, leather.	Leeds, Bradford, Sheffield. Derby, Notts, Leicester.
Northumberland and Durham.	Cleveland, Spain, Sweden.	Over 1200.	Shipbuilding, machinery, coal export, chemicals.	Newcastle, Sunderland, Middlesbrough.
South Lancashire.	Spain.	About 2400.	Cotton, chemicals, machinery.	Manchester, Liverpool.
Lanark.	Spain.	About 2000.	Shipbuilding, machinery, chemicals.	Glasgow, Paisley, Greenock.
North Stafford. South Stafford.	Leicester.	About 1000.	Pottery. Iron goods.	Stoke, Crewe Birmingham.

Each of the smaller coalfields is densely populated, but the above are the chief districts where coal is the main cause of the density of population. It is interesting to contrast the density of population on the coalfields with that of agricultural and pastoral regions. Thus, Huntingdon, one of the richest

agricultural counties, has about 300 persons per square mile; Norfolk, 225; Hampshire (including Southampton and Portsmouth), nearly 500; while the North Riding (including the North York Moors and Middlesbrough) has a population of about 185 per square mile; Queen's County, less than 250; Dorset, less than 300; while Ross and Cromarty (grouse moor and deer forest) has less than 50 persons per square mile.

Types of Towns.

In 1750 there were two large towns—London and Bristol; in 1850, 50 per cent. of the population lived in urban areas; in 1901, 77 per cent.; in 1911, 78 per cent.

(1.) **Ancient, Administrative, Market, and Ecclesiastical Towns.** (Population 6,000–30,000.)

(2.) **Ports.**

(*a*) Till 1750 trade was scattered among little ports. From 1750 to 1850 trade was concentrated in a few places.

(*b*) There were a few naval bases before the Great War.

(*c*) Fishing towns, except Grimsby, depend on other industries.

(3.) **Manufacturing Towns.**

(*a*) Factories without power give small towns—*e.g.* Newbury (Berks) and Witney (Oxon), as woollen centres; Northants, leather; High Wycombe, furniture.

(*b*) Water-power gave rise to the Pennine towns.

(*c*) Coal is responsible for the present size of most of the manufacturing towns.

(4.) **Mercantile Centres.**—The middleman is still the most important person in trade. Trade towns include London; Manchester-Salford, as the centre of Lancashire; Birmingham of the Black Country; Newcastle of Tyneside; and Liverpool of the greater part of England; while Bristol is the trade town of the west of England.

(5.) **Residential Towns.**—Special towns for the well-to-do have grown up since the conquest of India—*e.g.* Bath, Ton-

bridge Wells, Cheltenham, Leamington, Buxton, Matlock, and Harrogate. Later certain places—*e.g.* Brighton, Weymouth, the Channel towns such as Bournemouth and Eastbourne—have become residential towns at the seaside. Blackpool, Douglas, Scarborough, and the east coast and Welsh resorts depend for their existence on the annual holidays of the working and lower classes.

(6.) Suburbs have been developed by horse trams, electric trains, and buses. They are either residential or industrial, and generally speaking they are very badly governed.

Types of Town Councils.

(1.) **County Boroughs.** (Population 50,000 or over.)—These are the chief authorities for the maintenance of roads and streets, administration of Public Health and Housing Acts, education, police, fire brigade, lighting, water supply, tramways, improvements, parks, museums, libraries, washhouses, lunatic asylums, and cemeteries.

(2.) **Borough Councils.**—These have the same powers, but if of less population than 10,000 have no control over police, education, lunatic asylums, and the maintenance of the main roads.

(3.) **Urban District Councils.**—These do not even control elementary education, have no prestige or real power, but often govern more than 100,000 at the most critical stage of the growth of the towns.

London is a special case. It is under a County Council governing four and a half million people. This Council is the single authority for education, main drainage, fire, asylums, trams, bridges, parks, improvements. Under it are twenty-eight metropolitan boroughs, which are responsible for the cleaning and maintenance of streets but not of main roads, and for the administration of public health and housing. The rates in London vary. In 1916–17 the rates of the City area were 6s. 8d., and of Westminster 7s.; while Bermondsey had

a rate of 9s. 5d., and Poplar one of 11s. 10d. in the pound. This means that the poor have to maintain the very poor who live in the slum districts.

Pre-War Features of English Town Life.

Compared with Continental cities our towns were ugly but healthy. The smoke nuisance made everything drab. Education was slowly improving, and drunkenness, crime, and illiteracy were becoming less. Concerts, lectures, menageries, and circuses were not popular, while indoor entertainments —music halls, cinemas, and theatres—were well attended. Games were played, but 90 per cent. of the population did not play at all. Previous to the war people mixed little, and spent little time in their own homes. The day's programme included working eight to twelve hours, and as entertainment the indoor entertainments, the working men's clubs, the public-houses; while the children were occupied with day and night schools, or ran about the streets after day school, finding whatever enjoyment was possible in their very limited surroundings. There was no general attempt to provide open spaces for outdoor recreation after working hours. Life was rather dull for many.

Pre-War Features of Village Life.

Suburban.—Most inhabitants of suburbs found employment at a distance from their homes, which they used as sleeping-places.

Industrial.—Two main types of industrial villages exist: (1) Mining and quarrying, and (2) fishing villages.

Markets.—In the market villages local trade centres. The village has a weekly market and an annual feast or fair.

Agricultural.—This is the chief type of village, and is generally situated at the meeting of two highways, at a ford or bridge, in a forest clearing, or near a good water supply, a river, or a line of springs in valley bottoms on alluvial soils (Saxon type).

Agricultural labourers were very poor. They were numerous and without ambition. Though they were healthy, their cottages were poor and their wages low (12s. a week and allowances, amounting in all to a value of 16s. a week, about equal to £1 a week in a town, was the average wage before the war). There was a considerable difference between English, Scottish, and Irish labourers. The Scottish villages were more prosperous, the farmers were wealthy, and there was little poverty. The labourer's wage was about 22s. a week, about equal to 26s. a week in town. The Irish labourer was a migrant, coming to England for the harvest months, when the demand for labour on the farms is greatest. The agricultural labourer's work allowed of no holiday.

The **mining villages** had a much higher standard of wages. Two pounds a week or more was an average wage before the war, and the joint family income was often over £400 a year. A large part of the income was spent on whippet-racing, football trips, picture-houses, betting, and drink. The miner frequently lived in a crowded house, where it was necessary to have a bed in the kitchen. Another feature of the mining village was the local co-operative store. The miner was fond of music, and many villages had really first-class brass bands which competed in local contests.

In Ireland most of the population lived in villages. Irish emigration depended far more on whether conditions were good or bad in the U.S.A. than on conditions in Ireland. In 1908 the Irish labourer's wage was about 11s. a week.

The war emphasized the need for higher wages for farm labourers, with the result that farm workers received very substantial increases in wages under the Corn Production Act.

British Ports.

London.

(1.) London's bridge made it a centre of traffic north and south of the river, and prevented ocean-going ships sailing

up the Thames beyond London. The Thames estuary, affording a safe anchorage, faces the mouths of the Rhine (Rotterdam and Amsterdam) and the Elbe (Hamburg). As a result London has a great trade with the Continent.

(2.) The surrounding district is fertile, and helps to feed London's enormous population.

(3.) As it is the capital, London has become the great centre for government offices and for printing.

(4.) There are certain disadvantages in the situation of London. It has no coal, and is therefore not the centre of any great industry. The navigation of the estuary is difficult because of the mud-banks at the Thames mouth, while the climate is not particularly suitable for spinning.

(5.) As London, however, is the terminus of most of the great railways, and as it is linked up by the Thames with the Bristol Channel, the Midlands, the Mersey, and the Humber, it is the greatest distributing centre in the United Kingdom. Such a town, equipped with warehouses and joined by rail with the great centres of population, is called an entrepôt. Such towns, as a rule, have no great industries except those connected with the manufacture of the goods imported and the produce of the surrounding district. For example, the barley of Essex and the hops of Kent gave rise to brewing; the fruits of the "Home Counties" to jam-making; the wheat of the Thames valley to the manufacture of biscuits; the beech trees of the Chiltern Hills to the manufacture of furniture and chair-making; imported iron was obtained for the watch-making of Clerkenwell and the making of machinery; imported hides for the leather industry of Bermondsey; imported silk for the Spitalfields silk manufacture. Imported sugar is refined.

About one-third of the country's exports are sent out from London. The port of London receives the products of Australia, the East Indies, and Europe (including grain, wool, timber, tobacco, wine, fresh and dried fruits, tea, hides, teak, and partly manufactured goods from the Continent).

Liverpool.

Liverpool is situated on the navigable estuary of the Mersey, at the mouth of which is a dangerous sand-bar which requires constant dredging. The climate of the interior is suitable for the manufacture of textiles, while coal and iron are found in the district. Thus Liverpool has the import trade in cotton and wool for the cotton and woollen mills of Lancashire and Yorkshire, and the exporting of the finished cloth as its staple trade. There are excellent communications with the Midlands and with Yorkshire by railway and canal. Its situation opposite Dublin has given Liverpool the Irish trade in cattle, horses, and dairy produce. The imported vegetable oils and animal fats are made into soap and margarine in the district, while the nearness of Cheshire to the Lancashire coalfield has given rise to chemical industries in the neighbourhood of Liverpool.

Glasgow.

In 1800 the Clyde could be forded at Glasgow. Since then it has been artificially deepened, so that large vessels can reach the city. Glasgow has, however, developed outports at Greenock and Port-Glasgow. The surrounding district is rich in coal and iron, though the local " blackband " ironstone is now largely replaced by Spanish ore. The iron-smelting has thus attracted copper-smelting, the copper being obtained from Spain. As a result of the discovery of the steam-engine (Watt) Glasgow has become the greatest shipbuilding and engineering town in the British Isles. Salt is brought from the district of Preston (salt) Pans for the manufacture of chemicals. Glasgow has excellent communications inland by rail and river, and with the Firth of Forth by canal. The climate is suitable for textile industries (muslins, shawls, thread, and silk). The surrounding district is fertile, and helps to feed Glasgow's teeming population. Glasgow is

somewhat nearer Canada than is Bristol. Thus there is considerable trade with New York, Montreal, and Halifax, and cotton, grain, meat, and tobacco are imported.

Cardiff.

Because of the high tides of the Bristol Channel ships of great size can enter the Taff estuary. The steam-raising excellence of the coal of Glamorgan for naval and industrial purposes has made Cardiff the greatest coal port in the world. The nearness of the coal and iron of South Wales has given rise to coke-oven and chemical industries, and the smelting of iron and copper (originally from Cornwall). Cornish tin gave rise to the tin-plating industry. The tin is now chiefly obtained from the Malay Peninsula. The tinplate industry needs palm oil. Thus there is a considerable trade with West Africa. Cardiff has also a large share of the South American trade in grain and meat.

Hull.

There are two natural positions for ports at the concavities of the banks of the Humber mouth—Hull and Immingham. Both are sheltered, but Hull is more sheltered than Immingham. As the Humber estuary faces the Elbe, the imports of the Humber ports include grain, timber, flax and hemp, and their seeds, soya beans (from Manchuria), butter (from Denmark), eggs (from Siberia), and sugar (from Holland and Germany). Thus the industries of the towns on the estuary include milling, soap-making, margarine, sauce, cattle cake, and the making of confectionery.

As the Yorkshire wolds and Lincoln wolds are broken at the Humber, Hull and Immingham are the natural outlets of the valleys of the Ouse and the Trent. Thus coal is shipped from the Barnsley district, woollens from the West Riding, pottery, leather, lace, hosiery, and silks from the Trent basin, and iron and steel from the Sheffield area. Hull, Immingham, and Grimsby have the advantage of good

railway communications with the densely populated South Yorkshire and Trent valley coalfields. This, with the nearness of these ports to the Dogger Bank, has made Grimsby and Hull the chief British fishing ports. Originally a village at the mouth of the river Hull, Kingston was a little market town in the fertile Holderness district; but the destruction

FIG. 36.—Diagram showing the site of Hull.

of Ravenspur by the sea increased its importance, and a trade in exported wool and imported fish arose. The defences of the town consisted of moats, which made the town into an island. After the siege of Hull in the Civil War the moats were disused, and docks were constructed on their sites.

Bristol.

Bristol commands the route from the Thames valley to South Wales and Ireland, and thus controls the trade of the south of England in Irish cattle, horses, and dairy produce. The enterprise of its merchants gave it a considerable trade with North America, and it still retains a large trade in cocoa, coffee, bananas, tobacco, and sugar with the West Indies. Though the high tides of the Avon allow large vessels to reach its docks, Bristol has developed an important outport at Avonmouth. Bristol is situated on a small coalfield, though the coal is difficult to work.

Belfast.

The climate and the water of the district round Belfast are suitable both for the growth of flax and the manufacture of linen. Irish linen has been known since very early times. As a result of the revocation of the Edict of Nantes in 1685, Dutch and French Huguenots settled in Ulster and began to improve the native methods of manufacture. The introduction of cotton hindered the linen industry, but the American Civil War cut off the cotton supply, and the linen industry rapidly increased. It was found that flax could be more cheaply obtained from Russia. This caused a diminution of the acreage under flax, though of late flax cultivation in Ulster has increased. Women find employment in the mills, men in the shipyards. Thus Belfast is wealthier in a material sense than the towns of the north-east coasts of England, where there are few industries requiring female labour. Belfast is without local supplies of coal, but is able to obtain ample supplies from Cumberland and Ayrshire for its shipbuilding industry. Though situated on a well-sheltered deep-water estuary, Belfast has developed an outport and mail-packet station in Larne.

Newcastle.

(See Fig. 61, Map of North-east Coast.)

Newcastle has always commanded the route from England to Scotland along the east coast, for at this point the Tyne is joined by two wide valleys running north and south. Below Newcastle it was impossible to ford or bridge the Tyne, so the Romans made Newcastle the terminus of the Roman Wall. When the river was bridged finally, Newcastle was chosen as the lowest bridge town on the Tyne. The Normans erected a strong keep on the north side as a protection against the Scots. Finally, railway construction following the river valleys has made Newcastle the great bridge town of the North-eastern Railway. The steep banks of the Tyne made it possible to load coal vessels more easily than at Tees mouth, and thus Newcastle has become the chief outlet for the coal of Durham and Northumberland. The nearness of the mouth of the Tyne to supplies of coal, iron ore, and magnesian limestone, and its situation on navigable water, have led to the creation of iron and steel industries, including the manufacture of ships, ordnance, and machinery. The salt of South-east Durham is imported, and provides material for a considerable chemical industry. The disadvantage of the Tyne lies in the continual formation of a sand-bar at its mouth, which requires constant dredging.

Sunderland.

Sunderland exports the coal of Weardale. Iron is imported for its shipbuilding industry. Fibres are imported from the Baltic for its sailcloth industry. Glass is manufactured near the mouth of the Wear. The inland communications are not so good as those of Newcastle and of West Hartlepool, and as a result less pit props are imported than by Hartlepool and Newcastle.

Middlesbrough.

The deep docks of Middlesbrough have made it the chief port of the Tees estuary. The opening up of the iron mines of the Cleveland district, together with the nearness of the south and mid Durham coalfield, have given to Tees mouth the greatest iron-smelting industry in the British Isles. Later developments have been shipbuilding and the making of machinery, bridges, and rolling stock. These Middlesbrough shares with Stockton and Darlington. The salt works on the north bank of the Tees supply the Tyneside chemical works, while table salt (Cerebos) is prepared at Greatham, near Port Clarence. Manganese iron ore is necessary for the manufacture of steel. As a consequence Middlesbrough carries on a large trade with India. The imported iron ore is obtained from Spain, Greece, and Algeria. In spite of this, many of the vessels in the iron trade return to Spain in ballast. It is perhaps unfortunate that Middlesbrough is such a specialized port, and has not made provision for a more general trade. Recently, however, arrangements have been made for an increase in the exporting of coal. The Tees is not navigable for any great distance, and does not drain the mid-Durham coalfield, though there seems little reason why its tributary, the Skerne, should not be canalized, with the object of cheapening the freightage between Ferryhill and Teesmouth.

Portsmouth.

Portsmouth's sheltered position, and its nearness to the great French naval ports, made it the chief naval port in the days when France was the only other naval Power. The events of the past few years, however, have led to the establishment of other naval centres, particularly on the North Sea coasts. Both Portsmouth and Southampton owe much to the nearness of the New Forest, which provided timber both for shipbuilding and for the construction of docks. Both

at the present day are handicapped by the absence of coal and iron.

Southampton.

Southampton, situated at the junction of the Itchen with the drowned valley of the Test, is remarkable for the occurrence of four tides daily. This means that the largest ocean-going vessels can enter Southampton at any state of the tide. Thus Southampton is the Channel call port for European liners on their way to and from America. Its superior railway service has made Southampton the mail and passenger port for America and South Africa. Gold, diamonds, ostrich feathers, and wool are among its most important imports, while dairy produce is obtained from the Channel Islands. Southampton is the headquarters of the British Ordnance Survey, the greatest map-making institution in the British Empire, probably in the world.

Dundee.

Previous to the discovery of the use of coal in industry, Dundee was important as a whale-fishing port. Now, though it has a very considerable fishing industry, Dundee has developed into a large industrial town. Though Dundee has no coal or iron, these minerals are obtained from Fife, and machinery and shipbuilding industries are carried on. The Tay Bridge has made Dundee into a railway junction, and thus increased its importance. The fertile Carse of Gowrie is close at hand, and has led to the establishment of the jam industry. This has attracted the Spanish orange trade for the making of marmalade. Previous to the introduction of cotton for clothing, the making of linen was a household art in this part of Scotland. The nearness of the mouth of the Baltic gave Dundee cheaper fibre, and the linen and sailcloth industries were established on the estuaries of the Tay and the Forth. During the Crimean War the supply of Russian fibres was cut off. Jute was introduced from Bengal, and this led to the manufacture of jute at Dundee.

Leith and the Forth Ports.

The Forth is the outlet of the coalfields lying on its banks. Grangemouth is the port for the Stirling woollen and iron manufacture, Kirkcaldy for the coal and linen industries of Fife; Leith imports wood pulp for the paper and printing industries of Edinburgh; all the Forth ports are engaged to some extent in fishing; while Rosyth is one of our great North Sea naval bases. The Forth and the Clyde are connected by a shallow canal. To build a ship canal between them would increase the trade of both estuaries.

TONNAGE OF CHIEF PORTS.

Chief Ports, 1907–1911.	Tonnage (1,000).	Percentage of Total.
London	20,356	15.17
Liverpool	14,742	10.98
Cardiff	14,504	10.81
Newcastle	12,106	9.23
Southampton	8,202	6.11
Hull	6,696	4.91
Glasgow	5,220	3.89
Newport	3,762	2.8
Dover	3,470	2.58
Blyth	3,158	2.35
Middlesbrough	3,154	2.35
Plymouth	3,024	2.25
Manchester	2,980	2.22
Swansea	2,842	2.19
Leith	2,694	2.0
Grimsby	1,710	1.27
Bristol	1,612	1.20
Belfast	656	0.49

This table deals with tonnage only, and not with total value of cargoes.

The Populations of the Chief Towns.

Aberdare, 53,000. Colliery and iron industry.

Aberdeen, 165,000. Chief seaport in north of Scotland; has large textile industries; exports cattle and granite; university.

Acton, 64,000. Residential suburb of London ; Middlesex.

Airdrie, 24,000. Colliery and iron industry ; Lanark.

Alcester, 11,000. Small manufacturing town south of Birmingham, in Warwick ; makes needles and fish hooks.

Arbroath, 22,000. Manufacturing town ; Forfar.

Armagh, 7,000. Capital of Armagh.

Ashford, 12,000. Railway junction ; Kent.

Ashton-in-Makerfield, 19,000. Colliery and cotton-manufacturing town near Wigan.

Ashton-under-Lyne, 43,000. Cotton-manufacturing town near Manchester.

Astbury, 20,000. Silk-manufacturing town near Congleton, Cheshire.

Aylesbury, 11,000. Capital of Bucks ; lace and straw manufactures.

Ayr, 33,000. Capital of Ayr ; coal export ; iron and shipbuilding industries.

Banbury, 13,000. Railway centre in north of Oxfordshire ; dairy produce.

Barnes, 18,000. Suburb of London, on the Thames.

Barnsley, 54,000. Colliery ; linen manufacture.

Barrow, 80,000. Smelting and shipbuilding ; N. Lancashire.

Basingstoke, 11,000. Railway junction ; N. Hants.

Bath, 70,000. Health resort.

Bathgate, 7,000. Coal and oil-shale industries ; Linlithgow.

Batley, 36,000. Heavy woollen town, south of Leeds.

Battersea, 167,000. Suburb and borough of London, south of the Thames.

Beckenham, 26,000. Suburb of London ; Kent.

Bedford, 39,000. Capital of Bedford ; market town manufacturing agricultural implements.

Bedlington, 18,000. Iron and coal ; Northumberland.

Belfast, 386,000. Linen manufacture and shipbuilding ; commercial centre of Ulster.

Bermondsey, 117,000. In S.E. London; tanneries, wharves, and warehouses.

Berwick, 13,000. Railway town; has decreased in importance since the Union.

Bethnal Green, 130,000. In E. London.

Beverley, 13,000. Market and shipbuilding town; in Holderness, near Hull.

Birkdale, 14,000. Near Southport, Lancs.

Birkenhead, 140,000. Opposite to and shares the trade of Liverpool, on the Mersey.

Birmingham, 870,000.

Birtley, 8,000. Engineering town, south of Gateshead.

Bishop Auckland, 12,000. Market town near Durham; collieries.

Bitton, 12,000. Colliery near Bristol; Gloucester.

Blackburn, 130,000. Cotton manufacture; Lancs.

Blackpool, 62,000. Health resort; Lancs.

Blaydon, 20,000. Coal and iron industries; on the Tyne.

Bolton, 185,000. Cotton-manufacturing town; Lancs.

Boston, 15,000. Decayed seaport at mouth of river Witham.

Bournemouth, 85,000. Watering place; W. Hants.

Bourneville, 6,500. Model cocoa town in S. Birmingham founded by Mr. Cadbury.

Bowden, 25,000. Includes Altringham in Cheshire.

Bradford, 288,000. Worsted, woollen, and silk manufacturing town; W. Riding.

Brandon, 11,000. Colliery near Durham; manufactures coke.

Brentford, 15,000. Capital of Middlesex; residential.

Bridgwater, 16,000. Market; bathbrick manufacture; Somerset.

Bridlington, 14,000. Health resort near Flamborough Head.

Brigham, 9,000. On river Derwent, Cumberland.

Brighouse, 22,000. Woollen manufacture; near Huddersfield.

Brighton, 158,000. Watering-place, 50 miles south of London ; Sussex.

Bristol, 363,000. Seaport ; Gloucester.

Bromley, 33,000. Residential suburb of London ; Kent.

Bromsgrove, 8,000. South of Birmingham ; buttons and nails.

Broxburn, 7,000. Colliery and extracting plant for paraffins from oil-shale ; Linlithgow.

Budworth, Great, 25,000. Near Northwich ; Cheshire.

Burnley, 110,000. Cotton-weaving ; iron-manufacturing ; coal-mining ; Lancs.

Burton-on-Trent, 50,000. Brewing ; E. Staffs.

Bury, 58,000. Cotton manufacture ; Lancs.

Bury St. Edmunds, 16,000. Market town ; W. Suffolk.

Butterworth, 10,000. Part of Rochdale.

Buxton, 10,000. Health resort in Peak district.

Caerphilly, 16,000. Coal and iron ; Glamorgan.

Cambourne, 15,000. Tin and copper mining ; Cornwall.

Cambridge, 57,000. Market town and university.

Cannock, 24,000. Colliery ; W. Staffs.

Cardiff, 200,000. Exports coal ; manufactures iron and tinplate ; Glamorgan.

Carlisle, 52,000. Railway centre and cattle market ; capital of Cumberland.

Carlton, 10,000. Colliery ; Nottingham.

Carluke, 9,000. Colliery in fruit-growing district ; Lanark.

Carmarthen, 10,000. Market.

Carnarvon, 10,000. Capital of county.

Castleford, 17,000. Colliery and glass-bottle industries ; S. Yorks.

Chatham, 41,000. Naval base at mouth of Medway ; Kent.

Chelmsford, 19,000. Capital of Essex.

Chelsea, 74,000. S.W. of London.

Cheltenham, 50,000. Watering-place ; Gloucester.

Chertsey, 13,000. Residential town on Thames ; Surrey.

Chesham, 8,000. Chairmaking; Bucks.

Chester, 39,000. Railway centre.

Chesterfield, 37,000. Iron manufacture and colliery town; N.E. Derby.

Chester-le-Street, 12,000. Colliery town between Durham and Newcastle; junction.

Chichester, 12,500. Market; W. Sussex.

Chipping Wycombe (High Wycombe), 20,000. Chairmaking; Bucks.

Chiswick, 30,000. Engineering; boot polish; suburb of London; Middlesex.

Cirencester, 8,000. Woollen manufacture; Gloucester.

Clapham, 120,000. S.W. London.

Cleckheaton, 13,000. Woollens; near Bradford; Yorks.

Cleethorpes, 12,000. Watering-place near Grimsby; oysters.

Clerkenwell, 70,000. N. London; engineering.

Clifton, 24,000. Fashionable suburb of Bristol.

Clitheroe, 11,000. Cotton manufactures; Lancs.

Clydebank, 22,000. Shipbuilding and manufacture of sewing machines.

Colchester, 40,000. Iron industry; oyster fishery; military centre; Essex.

Coleraine, 7,000. At mouth of river Bann; linen.

Colne, 25,000. Cotton manufacture; E. Lancs.

Congleton, 11,000. Silks and cottons; E. Cheshire.

Consett, 10,000. Ironworks, west of Durham.

Cork, 76,000. Fishing; whisky; woollens.

Coventry, 119,000. Motor cars; cycles; silks; Warwick.

Crompton, 14,000. Colliery; near Oldham.

Croydon, 181,000. Residential town; Surrey.

Dalkeith, 7,000. Ironworks and mining; Midlothian.

Dalton-le-Dale, 14,000. Coal and iron; near Sunderland.

Darlington, 60,000. Railway centre, engineering, and woollen-manufacturing town in S. Durham.

Darwen, 38,000. Cotton and paper manufactures ; smelting ; near Blackburn.

Dawdon or Seaham Harbour, 10,000. Coal port ; glass-works ; near Sunderland.

Dawley, 8,000. Ironworks ; Shropshire.

Deal, 10,000. Ancient seaport and watering-place.

Denton, 15,000. Felt hat making ; near Manchester.

Deptford, 116,000. S.E. London ; port.

Derby, 126,000. Railway centre ; iron, pottery, and silk industries.

Devonport, 75,000. Naval station ; adjoins Plymouth and Stonehouse.

Dewsbury, 54,000. Woollen manufacture (shoddy) ; S. of Leeds.

Doncaster, 48,000. Collieries and ironworks ; railway centre.

Dorchester, 9,000. Capital of Dorset.

Douglas, 22,000. Capital of the Isle of Man ; holiday resort.

Dover, 43,000. Channel port and naval station.

Dowlais, 17,000. Colliery near Merthyr-Tydfil.

Dublin, 304,000. Capital ; Ireland.

Dudley, 50,000. Iron and pottery manufactures ; near Wolverhampton.

Dulwich, 30,000. Suburb of S. London.

Dumbarton, 20,000. Shipbuilding ; chemicals ; dyeing.

Dundalk, 13,000. Capital of Louth ; linen ; railway centre and port.

Dundee, 177,000. Linen ; shipbuilding ; jam ; jute ; fishing industries ; Forfar.

Dunfermline, 26,000. Linen (table) ; coal.

Durham, 15,000. Coal ; university.

East Ham, 156,000. E. London.

East Retford, 12,000. Agricultural implements.

Ebbw Vale, 20,000. Coal and iron ; Mon.

Eccles, 42,000. Silk, fustians, and ginghams ; S. Lancs.

Ecclesfield, 36,000. Cutlery ; near Sheffield.

Edinburgh, 332,000. Capital of Scotland ; university ; paper ; brewing.

Edmonton, 71,000. Suburb of London.

Elton, 12,000. Near Bury.

Ely, 7,000. Market in fruit-growing district of Cambridge.

Enfield, 61,000. Small-arms ; Middlesex.

Eston, 12,000. Iron and engineering industry; near Stockton-on-Tees.

Exeter, 61,000. Market ; capital of Devon.

Falkirk, 30,000. Iron-smelting ; Stirling.

Falmouth, 13,000. Port ; Cornwall.

Farnborough, 20,000. Military and aircraft centre ; E. Hants.

Farnworth, 26,000. Cotton manufacture ; near Bolton.

Faversham, 11,000. Market ; Kent.

Featherstone, 12,000. Colliery ; near Barnsley.

Fenton, 23,000. Pottery ; near Stoke.

Festiniog, 12,000. Slate quarries ; Merioneth.

Fleetwood, 12,000. Packet station ; fishery ; watering-place ; Lancs.

Folkestone, 32,000. Watering-place ; packet station ; Kent.

Forfar, 12,000. Jute and linen manufacture.

Fraserburgh, 9,000. Herring fishery ; N.E. Aberdeen.

Frome, 11,000. Woollens ; market ; near Bath.

Fulham, 138,000. Suburb of S.W. London.

Galashiels, 14,000. Woollens (tweeds) ; Selkirk.

Galway, 13,000. Fishery ; market.

Gateshead, 120,000. Iron and steel industries (railway plant).

Gillingham, 55,000. Suburb of Chatham ; Kent.

Glasgow, 1,000,000. Shipbuilding ; iron industries ; textiles ; chemicals.

Goole, 18,000. At confluence of Don and Yorkshire Ouse ; West Riding coal and woollen port ; flour mills.

Gorleston, 10,000. Watering-place ; Suffolk.

Gosport, 30,000. Naval seaport ; near Portsmouth.

Grantham, 20,000. Agricultural implements ; market.

Great Grimsby, 78,000. Chief fishing port.

Greenock, 78,000. Shipbuilding ; sugar-refining ; out-port of Glasgow.

Greenwich, 100,000. Observatory ; S.E. of London.

Guildford, 24,000. Market ; railway junction.

Halifax, 107,000. Manufactures carpets and woollens ; W. Riding.

Halliwell, 14,000. Cotton-manufacturing town near Bolton.

Hamilton, 36,000. Cotton and lace factories ; Lanark.

Hammersmith, 120,000 ; W. London.

Hampstead, 85,000. Residential borough ; N. London.

Handsworth, 54,000. Iron industry ; Staffs.

Hanley, 63,000. Pottery ; Staffs.

Harrogate, 30,000. Health resort (mineral springs).

Hartlepools, 90,000. Iron ; steel ; shipbuilding ; pit props ; fishery ; Durham.

Harwich, 11,000. Packet station (Holland).

Hastings, 66,000. Watering-place ; Sussex.

Heathtown, 10,000. Mining and iron ; Staffs.

Hebburn, 22,000. Shipbuilding ; colliery ; engineering.

Hebden Bridge, 8,000. Cotton manufacture and dyeing industry ; near Halifax.

Hebdon, 23,000. Suburb of London ; aircraft.

Hechmondwike, 9,000. Woollens ; W. Riding.

Heeley, 9,000. Iron ; near Sheffield.

Hereford, 22,000. Fruit-growing and agricultural market.

Hertford, 1,000. Market.

Hindley, 26,000. Colliery ; cotton ; near Wigan.

Holborn, 50,000. City of London.

Holmfirth, 9,000. Woollens ; near Huddersfield.

Hornsey, 74,000. Residential suburb of N. London.

Horsforth, 8,000. Iron and woollens ; near Leeds.

Horsham, 10,000. Barrels; market; Sussex.

Hove, 42,000. Suburb of Brighton.

Huddersfield, 111,000. Woollens and cottons; W. Riding.

Hull, 291,000. Commercial and fishing port.

Hyde, 33,000. Industrial market town; Cheshire.

Ilford, 80,000. Paper mills; photographic plates; Essex.

Ilfracombe, 9,000. Watering-place near Barnstaple; N. Devon.

Ilkeston, 31,000. Silk manufacture; iron and coal; Derby.

Ilkley, 7,000. Health resort; W. Riding.

Ince-in-Makerfield, 23,000. Colliery and cotton manufacture; near Wigan.

Inverness, 22,000. Woollens (cloth and tweeds); fishery; market.

Ipswich, 74,000. Market and engineering centre.

Jarrow, 36,000. Shipbuilding; steel works; near Newcastle.

Keighley, 43,000. Woollen machinery manufacturing town.

Kendal, 14,000. Market; Cumberland.

Kensal Green, 11,000. Suburb of London.

Kensington, 185,000. Residential borough of London.

Kentish Town, 52,000. Residential district; N.W. London.

Kilkenny, 10,000. Market.

Kilmarnock, 35,000. Textile industry; ironworks; market.

King's Lynn, 21,000. Decayed seaport; Norfolk.

King's Norton, 58,000. Iron manufacture; S. of Birmingham.

Kingston, 36,000. Residential and market town on Thames; Surrey.

Kingstown, 17,000. Outport of Dublin; fishing; watering-place.

Kirkintilloch, 11,000. Iron-smelting; Dumbarton.

Lambeth, 300,000. Industrial; S. London.

Lancaster, 40,000. Market.

Larkhall, 15,000. Colliery; near Glasgow.

Launceston or Dunhevid, 24,000. Fruit market; Cornwall.

Leeds, 450,000. Woollen centre; W. Riding.

Leicester, 232,000. Hosiery; lace; leather.

Leigh, 44,000. Coal; cotton; near Wigan.

Leith, 80,000. Fish; whisky; port of Edinburgh.

Lewes, 11,000. Market; Sussex.

Lewisham, 145,000. Residential; S.E. London.

Lincoln, 60,000. Market.

Litherland or Waterloo, 25,000. Suburb of Liverpool.

Littlebrough, 11,000. Woollen and dyeing; cotton; near Rochdale.

Liverpool, 765,000.

Liversedge, 14,000. Woollens; near Dewsbury.

Llandudno, 10,000. Seaside resort; Carmarthen.

Lockwood, 10,000. Woollens; near Huddersfield.

London, 4,500,000.

Londonderry, 40,000. Market for agricultural products and fish; linen.

Loughborough, 23,000. Hosiery; Leicester.

Louth, 9,000. Market; Lincoln.

Luton, 55,000. Straw plait; Bedford.

Macclesfield, 35,000. Silk and cotton; Cheshire.

Maidstone, 34,000. Market; Kent.

Malvern, 16,000. Health resort; Worcester.

Manchester, 716,000. Cotton market of the world.

Mansfield, 36,000. Lace; leather; colliery; Nottingham.

Margate, 30,000. Holiday resort; Kent.

Masbrough, 9,000. Iron; near Rotherham.

Mexborough, 10,000. Colliery; near Doncaster.

Middlesbrough, 101,000. Iron-smelting; shipbuilding; coal export; N. Riding.

Middleton, 26,000. Cotton; S.E. Lancs.

Mirfield, 11,000. Woollens; near Huddersfield.

Morpeth, 8,000. Colliery.

Neath, 14,000. Copper; tin; chemicals; coal export; near Swansea.

Newbury, 11,000. Woollens; Berks.

Newcastle, 273,000. Iron; shipbuilding; chemicals; coal export.

Newcastle-under-Lyme, 20,000. Pottery; brewing; paper-making; Staffs.

Newmarket, 11,000. Racing centre; Cambridgeshire.

Newport, 89,000. Shipbuilding; iron; Monmouth.

Newton Abbot, 9,000. Market and junction town.

Newton Heath, 32,000. N.E. Manchester.

Newtownards, 9,000. Linen; oysters; Down.

Normanton, 13,000. Colliery; W. Riding.

Northampton, 93,000. Boots.

North Brierley, 24,000. Woollens; iron; near Bradford.

Northfleet, 14,000. Shipbuilding; near Gravesend (28,000).

Northwich, 18,000. Salt; Cheshire.

Norwich, 124,000. Market; small industries.

Nottingham, 259,000. Lace; hosiery; leather.

Nuneaton, 37,000. Colliery; Warwick.

Oldbury, 27,000. Market; Worcester.

Oswestry, 17,000. Cambrian Railway works; cattle market yarn manufacture.

Otley, 10,000. Machinery; paper; leather; W. Riding.

Oxford, 52,000. Market; university.

Paddington, 148,000. Borough of N. London.

Paignton, 8,000. Health resort; fishing village; Devon.

Paisley, 87,000. Textiles; engineering; near Glasgow.

Patricroft, 12,000. Cottons; near Manchester.

Pemberton, 23,000. Manufacturing town; near Wigan.

Pembroke, 16,000. Dockyard.

Pembroke, 29,000. N. of Dublin.

Penarth, 15,000. Coal port; Glamorgan.

Penrith, 9,000. Market; Cumberland.

Penzance, 13,000. Fishing; copper; tin; china clay; Cornwall.

Perth, 36,000. Dyeing; floorcloth; wincey; linen; glass.

Peterborough, 33,000. Engineering centre; brickworks; Northants.

Peterhead, 12,000. Granite; fish; E. Aberdeen.

Plumstead, 34,000. Arsenal district of Woolwich.

Plymouth, 117,000. Shipbuilding; engineering; fort; Devon.

Pollokshaws, 11,000. Residential suburb of Glasgow.

Pontefract, 16,000. Coke ovens; near Wakefield.

Pontypridd, 34,000. Market town for Rhondda valley; iron; coal; Glamorgan.

Port-Glasgow, 18,000. Shipbuilding; near Glasgow.

Portsmouth, 245,000. Naval port; Hants.

Preston, 115,000. Cotton; Lancs.

Queenstown, 9,000. Calling port; near Cork.

Radcliffe, 81,000. Paper; dyes; near Manchester.

Ramsbottom, 16,000. Calico-printing; quarries.

Ramsgate, 30,000. Holiday resort.

Rawmarsh, 15,000. Iron; coal; near Rotherham.

Reading, 78,000. Biscuits; market.

Redditch, 14,000. Needles and fishhooks; Worcester.

Redhill, 12,000. Residential town; near Reigate (28,000).

Redruth, 11,000. Tin mine; Cornwall.

Renfrew, 12,000. Textiles; iron.

Richmond, 33,000. Residential town; near London; Surrey.

Ripley, 10,000. Manufacturing town; Derby.

Ripon, 8,000. Market; N. Riding.

Rochdale, 91,000. Cotton and woollen mills; near Manchester.

Rochester, 30,000. Seaplanes; cathedral; near Chatham.

Rotherham, 65,000. Iron and chemical works; near Sheffield.

Rotherhithe, 38,000. Port in S.E. London.

Rothesay, 9,000. Holiday resort; Bute.

Royton, 15,000. Cotton; near Oldham.

Rushden, 13,000. Leather; Northants.

Rusholme, 12,000. E. Manchester.

Rutherglen, 19,000. Chemicals; dyes; ropes; cottons; Lanark.

Ryhope, 8,000. Colliery; glassmaking; near Sunderland.

Ryton, 8,000. Ironworks; on the Tyne.

Saddleworth, 24,000. Woollens; near Huddersfield.

St. Albans, 25,000. Cathedral city; controls route across the Chiltern Hills from London; site of famous battles.

St. Andrews, 7,000. University town; Fife.

St. Helens, 100,000. Glass; alkalis; coal; iron; Lancs.

St. Helier, 30,000. Watering-place and fort; Jersey, Channel Is.

St. Leonards, 28,000. Watering-place.

St. Marylebone, 141,000. N.W. London.

Sale, 13,000. Cheshire.

Salford, 240,000. Cotton; near Manchester.

Salisbury, 21,000. Market.

Saltley, 10,000. Rolling stock; Birmingham.

Scarborough, 40,000. Fishing; watering-place; N. Riding.

Selby, 8,000. Oilcake; milling; sauce; shipbuilding.

Sheerness, 20,000. Naval port; Kent.

Sheffield, 476,000. Cutlery; steel.

Shipley, 26,000. Woollens; sauce; W. Riding.

Shoreditch, 120,000. E. London.

Shrewsbury, 29,000. Woollens; market.

Skipton, 12,000. Woollens and threads; W. Riding.

Small Heath, 13,000. Hardware; Birmingham.

Smethwick, 76,000. Hardware; rolling stock; Birmingham.

Southampton, 120,000. Calling station; outport of London.

Southend, 87,000. Watering-place; Essex.

Southgate, 16,000. Residential town; near Barnet.

Southport, 71,000. Holiday resort ; Lancs.

South Shields, 105,000. Shipbuilding ; coal export.

Southwark, 207,000. Warehouses ; S. London.

Sowerby, 12,000. Woollens ; near Halifax.

Spalding, 9,000. Market ; Lincoln.

Spennymoor, 17,000. Coal and coke ; Durham.

Spitalfields, 22,000. Formerly a great weaving centre ; London.

Stafford, 20,000. Iron ; salt ; leather.

Stalybridge, 28,000. Cotton ; iron ; Cheshire.

Stirling, 19,000. Market ; coal ; woollens.

Stockport, 108,000. Cottons ; Lancs. and Cheshire.

Stockton, 52,000. Iron and steel ; engineering.

Stoke, 241,000. China ; pottery.

Stourbridge, 15,000. Glass ; firebrick ; Worcester.

Stratford-on-Avon, 8,000. Warwick.

Stretford, 32,000. Cotton ; near Manchester.

Sunderland, 150,000. Shipbuilding ; coal export.

Sutton, 19,000. Residential town ; near Croydon.

Sutton Coldfield, 20,000. Market ; residential town ; near Birmingham.

Sutton in Ashfield, 18,000. Colliery ; near Mansfield.

Swansea, 121,000. Coal export ; iron ; copper ; tin.

Swindon, 50,000. Railway centre ; market.

Swinton, 29,000. Near Manchester.

Swinton, 12,000. Near Sheffield.

Taunton, 22,000. Market.

Thornhill, 10,000. Woollens ; near Dewsbury.

Tipton, 31,000. Iron ; near Wednesbury.

Tiverton, 10,000. Lace ; fruit ; Devon.

Todmorden, 26,000. Woollens ; W. Riding.

Torquay, 39,000. Seaside resort.

Tottenham, 137,000. N. London.

Tredegar, 19,000. Iron ; Monmouth.

Trowbridge, 11,000. Cloth manufacture ; near Bath.

Truro, 12,000. Tin-smelting ; jam ; Cornwall.

Tunbridge Wells, 35,000. Health resort; Kent.

Tunstall, 20,000. Pottery and ironworks; Staffs.

Twerton, 12,000. Bricks; cloth; near Bath.

Twickenham, 23,000. Residential town; S.W. of London.

Tyldesley, 15,000. Cotton; near Bolton.

Tynemouth, 58,000. Health resort.

Ulverston, 10,000. Paper; hardware; N.W. Lancs.

Uxbridge, 8,000. Market; Middlesex.

Wakefield, 52,000. Woollens; colliery.

Wallsend and Walker, 45,000. Suburb of Newcastle.

Walsall, 90,000. Hardware; bits, bridles, saddlery; near Birmingham.

Walthamstow, 134,000. S.W. Essex.

Walton-on-the-Hill, 49,000. Suburb of Liverpool.

Warrington, 71,000. Wire; pins; files; tools; near mouth of the Mersey.

Warwick, 12,000. Residential town.

Watford, 32,000. Cocoa; printing; Herts.

Wath-on-Dearne, 9,000. Colliery; near Barnsley.

Wednesbury, 28,000. Earthenware; iron; coal; Staffs.

Wellingborough, 19,000. Iron-smelting; leather; Northants.

Wenlock, 16,000. Coal; iron; Shropshire.

West Bromwich, 68,000. Machinery; tools; metal goods.

West Derby, 40,000. Suburb of Liverpool.

West Ham, 298,000. Chemicals; iron; Essex.

Westminster, 192,000. Centre of Government offices; London.

Weston-super-Mare, 21,000. Health resort; Somerset.

West Stanley (including Annfield Plain), 40,000. Colliery; N. Durham.

Wexford, 11,000. Fishing port.

Weymouth, 21,000. Port for Channel Islands.

Whickham, 14,000. Colliery; near Gateshead.

Whitby, 12,000. Holiday resort; N. Riding.

Whitehaven, 19,000. Coke; iron-smelting; shipbuilding; coal export; Cumberland.

Whitley Bay, 9,000. Holiday resort; near N. Shields.

Whittington, 10,000. Colliery; near Chesterfield.

Wick, 8,000. Fishing port; Caithness.

Wickham, 8,000. Colliery; near Newcastle.

Widnes, 31,000. Iron; copper; soda; candles; soap; manures; Lancs.

Wigan, 91,000. Coal; iron; cotton; paper.

Willington, 9,000. Coke; near Bishop Auckland.

Winchester, 21,000. Market; Hants.

Windsor, 13,000. Residential town.

Wisbech, 10,000. Exports coal; Isle of Ely.

Woking, 18,000. Junction on L. & S.W. Railway; near Guildford; Surrey.

Wolverhampton, 100,000. Iron hooks, keys, machines, tools; zinc and tin; Staffs.

Wombwell, 14,000. Colliery; near Barnsley.

Worcester, 48,000. Agricultural market; porcelain; iron.

Workington, 27,000. Ironworks, cycles and motor-cars; coal.

Worksop, 17,000. Chairmaking; near Sherwood Forest, Notts.

Worsborough, 11,000. Colliery; near Barnsley.

Worsley; 13,000. Cotton; near Manchester.

Worthing, 33,000. Watering-place; Sussex.

Wrexham, 18,000. Market; Denbigh.

Yarmouth, 55,000. Fishing port and health resort.

Yeovil, 13,000. Gloves; motor-cars.

York, 82,000. Milling; cocoa; wagon works.

Questions and Exercises.

(1.) Show clearly how the industries carried on at Belfast, Birmingham, Dundee, and Stoke-on-Trent were favoured in the beginning by geographical conditions, and how, from their positions, Chester, Durham, Limerick, and Stirling naturally became places of importance in very early times.

(2.) Explain why in Monmouthshire, contrary to the general rule, the hilly portion is more thickly populated than the plain. Compare the climate, vegetation, and productions of the two areas. Draw a map showing the railway system of the county.

(3.) Discuss the statement, "An indented coastline is said to be favourable to trade."

(4.) "The settlements of man are less dependent on physical conditions than in former times." From your knowledge of the British Isles, show how you can justify this statement. Deal fully with any one instance.

(5.) Select one of the great seaports of the world outside the British Isles. Describe its position carefully, give an account of its trade, and state fully the causes which have made it important.

(6.) Give an example of (*a*) a region where there is a population largely engaged in agriculture, and (*b*) a region where most of the people live in towns. Describe the two regions you select and account for the facts.

(7.) What is the chief industry in each of the following towns: Bradford, Grimsby, Manchester, Middlesbrough, Southampton? Account for the industry prevalent in each.

(8.) Give an account of the distribution of the population in Wales. Give reasons for the facts you mention.

(9.) What are the chief requirements of a commercial seaport? Give examples.

(10.) The average size of ocean-going vessels has greatly increased during recent years. Discuss fully, with examples, the effect of this on the size and position of modern seaports.

(11.) Compare the general distribution of population in Scotland and Ireland. Account for the differences you point out.

(12.) "Early British trade with the Continent produced a series of towns along the southern and eastern coasts." Give examples of such towns. Describe and account for their positions. Say whether they have flourished or decayed in modern times, and account for the facts.

(13.) Give an example of a region which supports a dense settled population engaged in agriculture. Explain the conditions which make this possible in the region you select. Name the most important crops cultivated.

(14.) Some towns in England are described as "railway creations." Describe carefully the positions of two such towns, and state the geographical conditions which account for the growth of each.

(15.) What parts of Europe are the most densely populated? How do you account for the facts?

(16.) Explain the statement, "Density of population often depends on rock formation."

(17.) Where exactly are Ventnor, Belfast, Barrow, St. Andrews, and Holyhead? Why is each important, and what geographical reasons can you give for its growth just where it is?

(18.) How is it that:—(*a*) there are so many cathedral cities in the eastern half of England; (*b*) the heaths round London (such as Blackheath) are now so famous for schools and were once notorious for highwaymen; (*c*) the sites of many old Roman camps are now occupied by railway junctions; (*d*) so many small articles—such as pins, pens, screws, watch-springs, etc.—are made in the Birmingham district?

(19.) Explain, giving examples, the influence of physical geography on (*a*) the position, (*b*) the growth of towns.

(20.) Discuss the economic value of rivers to man, and show how their natural conditions may be improved. Give actual instances in support of each point in your answer.

(21.) What are the chief advantages that Great Britain derives from her geographical position? How far are these advantages likely to exist permanently?

(22.) How do you account for the concentration of economic life in the central belt of Scotland?

(23.) Enumerate the circumstances which have led to the development of seaports in the north of England.

(24.) Point out the chief regions of dense population in

England, and in each case show the chief causes to which the density is due.

(25.) "The attraction of the towns of which we hear so much is in reality the attraction of minerals." Consider how far this statement is true, illustrating your remarks by examples from Great Britain and Ireland.

(26.) Construct a map of your home district or county. Shade the densely populated areas. Account for the facts.

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CHAPTER VII.

PHYSICAL FEATURES OF THE BRITISH ISLES.

For the names of the physical features a good physical features map is necessary; for the chief rock systems a geological map must be used.

The physical features of a country are determined by the nature of its rocks, by the movements of the earth's crust, and by denudation.

Movements of the Earth's Crust.

It is necessary to look upon the earth's crust as floating on a dense liquid inside the earth. As the lightest bodies sink least into the liquid in which they float, so the highest mountains are composed of the lightest, and the level plains and ocean

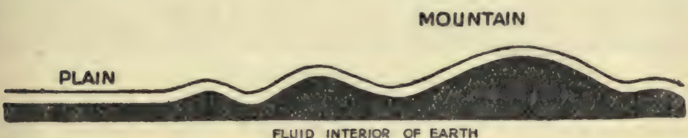

Fig. 37.—Diagram illustrating the Fluid Nature of the Earth's Interior.

floors of the heaviest materials. Mountains thus represent the weak portions of the earth's crust. In regions where weakness exists earthquakes occur, and volcanoes come into existence. When the pressure on the earth's crust becomes

too great it breaks and forms a "fault." Originally the layer was continuous, but the pressure became too great and a fault was formed. There has been subsidence of this kind in the Central Lowlands of Scotland, forming the rift valley of the Forth and Clyde. Similarly the Great Glen occupied by the Caledonian Canal is a faulted valley which has been deepened by denudation.

The British Isles contain no recently formed large moun-

FIG. 38.—A Small Fault in the Gorge, Roundhay, Leeds.

tains, though the Pennines exhibit folding, and consequently no volcanoes. There is evidence, however, that in the past mountains have been formed and volcanoes have existed. The rounded heights of Snowdon, Cader Idris, Skiddaw, Dartmoor, Arthur's Seat and the Castle Rock at Edinburgh, are of volcanic origin, and tabular sheets of basalt in Antrim (Giant's Causeway) and in certain islands (*e.g.* Fingal's Cave)

off the west coast of Scotland indicate the former existence of active volcanoes.

The elevated regions of the British Isles are composed of hard and ancient rocks. These are confined to the west

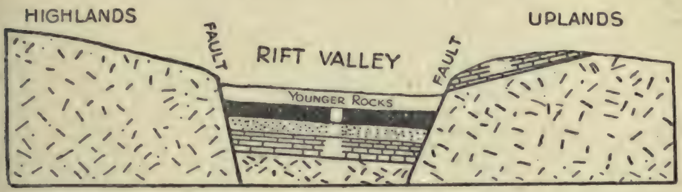

FIG. 39.—Diagram illustrating the Formation of a Rift Valley.

and north-west, the southern and eastern parts being composed of softer secondary rocks, the more resistant of which stand out as escarpments, the less resistant rocks forming plains and valleys.

DENUDATION.

The present physical features of these islands owe much more to the agents of denudation than to the crustal movements of the earth. Denudation is the process by which water, ice, acids, frost, wind, vegetation, and changes of temperature, wear away the prominences of the earth's surface.

(1.) The Action of Running Water.

Rain falls in mountainous regions and runs down the slopes till it gets to sea-level. In running down the slope it carries with it rocks and stones which assist the digging action. This action of digging into the bed of a stream is called erosion, and its effect is most marked in the hilly regions where potholes are frequently found in the beds of the streams.

The tides on the coasts have the power of undermining cliffs between the levels of high and low tides. Thus the sea coasts of the British Isles are being gradually reduced to sea-level.

A

B

FIG. 40.—Photographs showing the effect of rain.

(*a*) Gorge cut in Burnsall Fell during a storm lasting less than two hours.
(*b*) Parallel stream channels cut in the side of a pit heap at East Howle, co. Durham.

This marine erosion is naturally most active on those coasts which are composed of soft rocks. Thus the east and south-east coasts are suffering considerable losses each year. Within historical times large tracts of country have been inundated—Lyonesse, from Mount's Bay towards the Scilly Isles, the Lost Lowland Hundred or Cantref-y-Gwaelod in the south

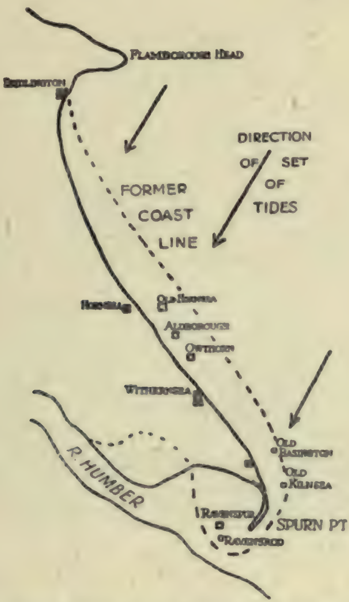

FIG. 41.—Sketch Map of the Lost Towns of Holderness.

of Cardigan Bay, the Goodwin Sands, large parts of Norfolk, Suffolk, Essex, Kent, and Sussex bear witness to the sea's destructive power. Some writers attribute the losses to subsidence as the sole agent of the loss, but the majority believe that the destruction was in each case caused by the tides, especially those reinforced by onshore winds. The case of Holderness is worthy of special mention. The present rate

of loss amounts to eight yards per annum in some parts. Much of the soil is then drifted by the tides into the mouth of the Humber, where it increases the size of Spurn Head.

(2.) The Action of Frost—Weathering.

When water freezes it expands ; thus frost causes wet parts of the face of a cliff to break off. As a result, weathering

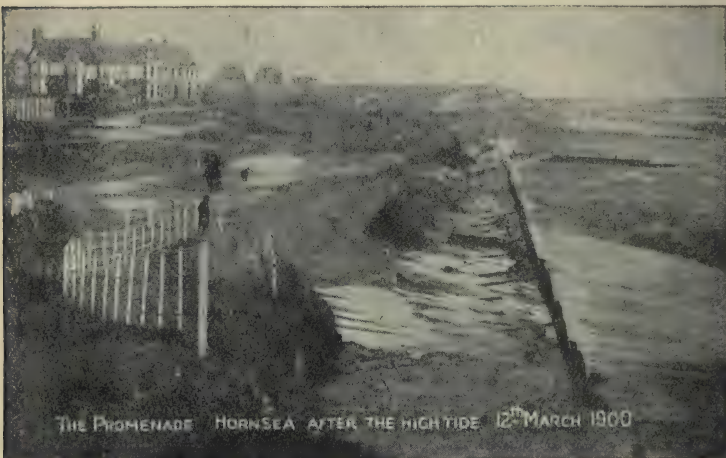

Fig. 42.—The erosive effect of a high tide, backed by a strong onshore wind, at Hornsea. The material washed away is generally deposited at the mouth of the Humber.

helps to widen the valley as the stream deepens it. As in this country we have considerable rainfall and alternate freezing and thawing in the winter months, the process of widening keeps pace with the action of rivers in deepening the valleys. Thus, as a rule, the English landscape is one of gentle slopes, with few river gorges. It is otherwise in hot desert regions which have streams flowing through them. In such regions cañons can exist, sometimes more than half a mile deep.

FIG. 43.—The Dropping Well, Knaresborough. Objects placed in the water are quickly "petrified."

(3.) The Action of Water containing Acids.

Water always contains a little carbonic acid gas, and this is much increased when a stream passes over ground containing decayed vegetable matter. Such a solution of carbon dioxide dissolves limestone. Thus water containing carbonic acid gas, on reaching a limestone district, dissolves a hole in the surface, called a swallow hole, and disappears underground. If it contains a large amount of gas in solution it will in course of time dissolve out a cavern. When the gas in solution escapes the limestone is redeposited. If the escape takes

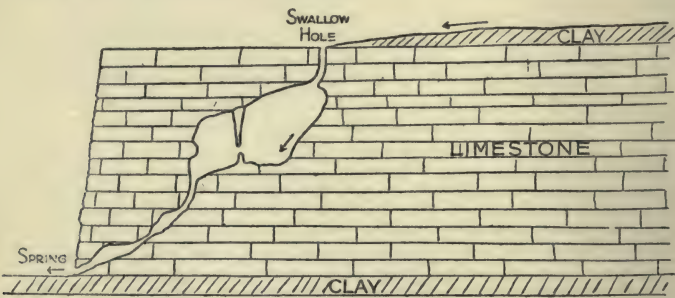

FIG. 44.—Diagram of a Limestone Cavern.

place as the drops of water fall from the roof of the cavern to the floor stalactites and stalagmites are formed.

The equation representing this reaction is

$H_2O + CO_2 +$	$CaCO_3$	$=$	$Ca(HCO_3)_2$
	Limestone (insoluble)		Calcium hydrogen carbonate (soluble)

This underground drainage is a characteristic feature of limestone districts. In such regions—*e.g.* the Pennines and the dry valleys of the Chalk scarplands—valleys are found which only contain water after very heavy rain, when there is too much water for the underground stream to carry off. Limestone districts are porous, and thus less subject to the action

of frost and surface water. Thus gorges, such as the Cheddar Gorge, are sometimes found in them.

(4.) The Action of Ice—Glaciers.

At the present time there are no glaciers in these islands, but during the Ice Age the greater part of the United Kingdom was covered with ice and snow.

Glaciers are formed by the accumulation of snow above the

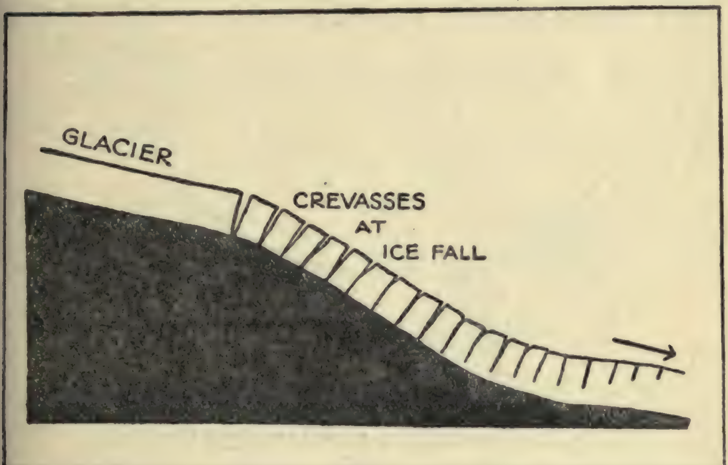

FIG. 45.—Diagram showing the Formation of an Icefall and Crevasses.

snow line on a mountain side, wherever a cup-shaped hollow capable of retaining snow occurs. The hollow in which the snow collects is called a *névé*. There are many such hollows in Britain, called *corries* in Scotland and *cwymns* in Wales, which mark the places where the glaciers finally melted. In the *névé* the snow is gradually compressed into ice, which then flows like a river down the mountain side. If the slope of the glacier bed suddenly becomes steeper the glacier breaks into crevasses and forms an icefall, though below the icefall

the glacier welds together again. In the upper part of the glacier, on the steeper slopes where snow cannot accumulate, frost is the chief agent of denudation, and showers of stones fall at sunset and sunrise from the jagged peaks on to the sides of the glacier below. As a result, the glacier carries down with it stone trains at the sides. Some of these stones fall down the crevasses, and those which reach the bed of the glacier scratch the ground and are themselves scratched. When the glacier melts these scratched stones and the stone trains (lateral moraines) are left as evidence of the course

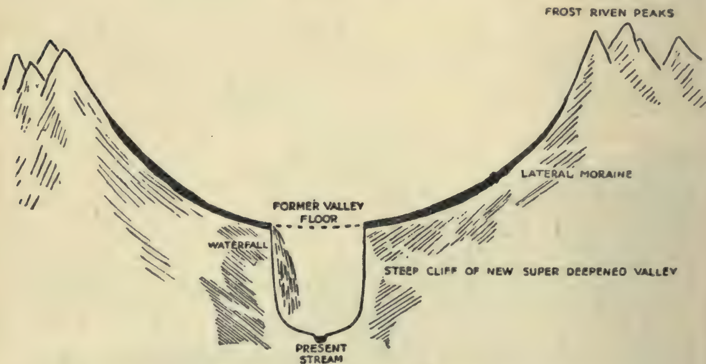

FIG. 46.—Section of a Valley formerly occupied by a Glacier.

taken by the glacier. At the bottom the glacier melts, and discharges its water into the valley below, frequently as a torrent. If the glacier is melting rapidly its discharged waters dig a gorge. When the ice has gone this superdeepened valley or gorge is left to mark the glacier's course. The result is that the tributary streams entering the valley fall from the walls of the newly made gorge. Their valleys are said to be hanging valleys. The waterfalls from the hanging valleys of Norway and Switzerland are used for the generation of electrical power.

If the lower end of a glacier remains stationary for any

length of time, on melting, it leaves a large heap of refuse to mark the place. This ridge across the valley is called a terminal moraine. Where the ice sheet has been very extensive and has melted slowly, the moraine material is laid down more evenly in the form of boulder clay. Where water has run over moraine material, the stuff is separated into sands and gravels. Where boulders have travelled on the top of an ice sheet far away from the point of origin, they are called "erratics." Thus boulders originally laid down in Scotland and Norway have been found in the glacial deposits of the Yorkshire coasts.

When a glacier discharges its ice into the sea icebergs are

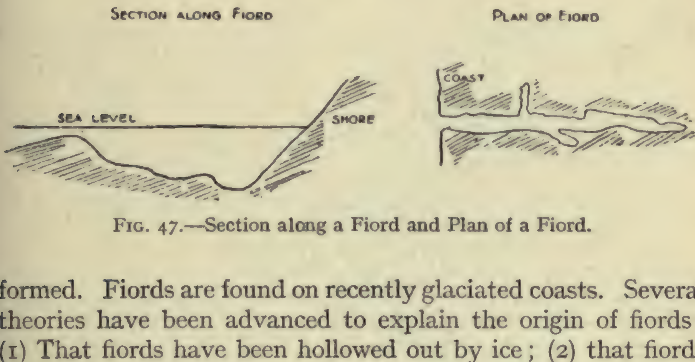

FIG. 47.—Section along a Fiord and Plan of a Fiord.

formed. Fiords are found on recently glaciated coasts. Several theories have been advanced to explain the origin of fiords: (1) That fiords have been hollowed out by ice; (2) that fiords are due to the submergence of the land, whereby the waters of the sea have invaded the inland valleys; (3) that in some cases rivers have been blocked by glacial material, thus causing the river to find a fresh outlet over a rocky ridge to the sea. The generally accepted idea at the present is that the valley has been hollowed out, and that submergence has followed, giving the characteristic form to the fiord. Examination of the west coast of Scotland gives evidence that many of the sea lochs are true fiords.

(5.) The Action of Wind.

In desert regions the chief agent of denudation is wind, which sometimes carries sand with tremendous force against cliff faces, causing the rock surface to weather along horizontal lines. There are few parts of the United Kingdom where the wind produces any marked effect, but the grooving of many of

FIG. 48.—Horizontal Grooves formed by Wind Erosion, Plumpton Rocks, Knaresborough. The vertical marks have been subsequently caused by rain.

the sandstones of the Millstone Grit series indicates that at one period parts of England were desert.

(6.) The Action of Heat and Cold.

In the desert the heat absorbed during the day is rapidly lost by radiation at night. This means that the rock faces

are subject to alternate expansion and contraction, which causes the rock surface to crack. In the British Isles the daily range of temperature is too small for this to occur on any considerable scale.

(7.) The Action of Vegetation.

Roots of plants secrete acids which dissolve the rocks below, turning them gradually into soil. Roots, however,

FIG. 49.—Photograph showing the Protective Action of Roots.

have also a protective action, and after soil has been formed tend to hold the soil together and prevent further wearing away. Thus the cutting down of trees and the removal of their roots often makes the destruction of the surface soil an easy matter during heavy rains.

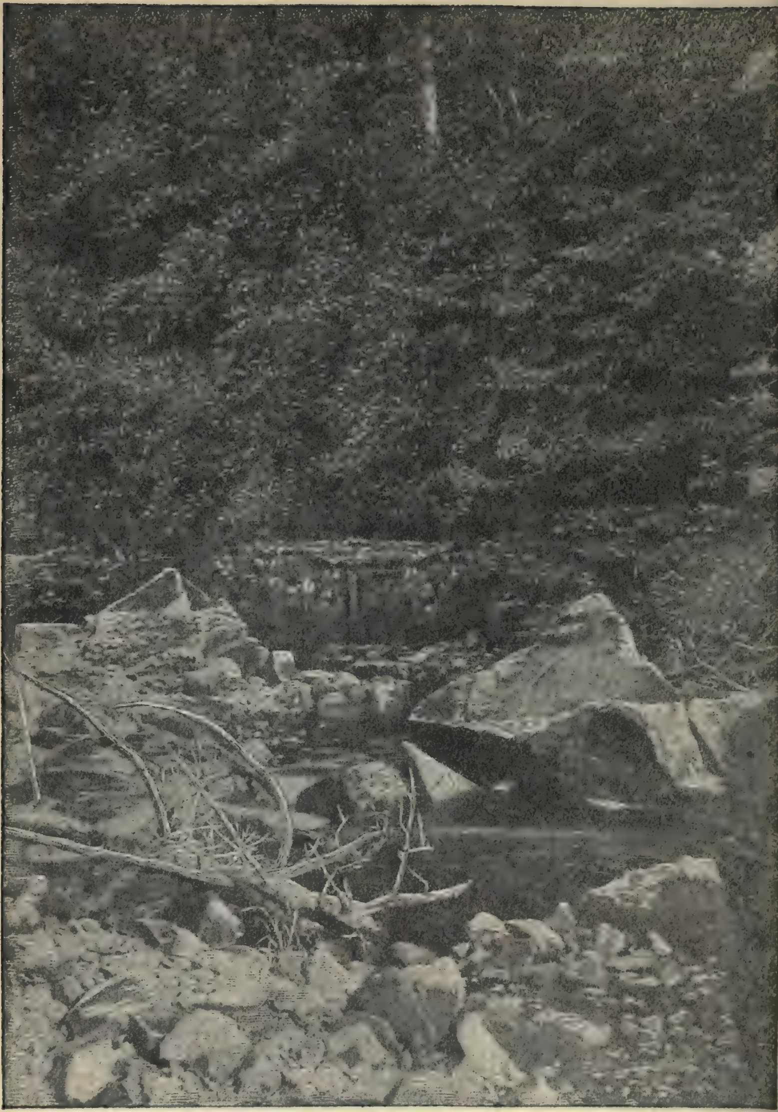

FIG. 50.—The Torrent Track of a Stream.

THE RIVERS OF THE BRITISH ISLES.

There are three main parts of a normal river's course: (1) The **torrent track,** where the river's main work is erosion; (2) the **valley track,** where the materials eroded are carried away; and (3) the **plain track,** where the river begins to deposit the rock waste it carries.

(1.) **The Torrent Track.**—Erosion does not take place at the actual source, which most frequently is on an almost

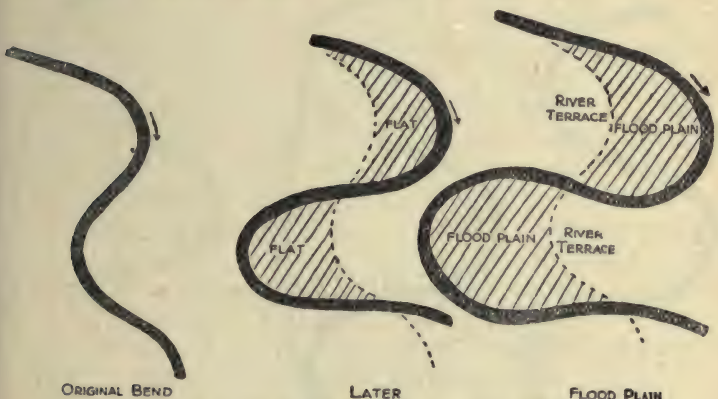

FIG. 51.—The Formation of a Flood Plain.

flat watershed, so much as at the place where the little becks run together and form one stream.

(2.) **The Valley Track.**—There is much less erosion here, and the stream contains as much débris as it can carry.

(3.) **The Plain Track.**—Here the volume of water is at a maximum, but as the slope is slight little erosion is carried on; the load of débris is gradually thrown down and fills up the bed of the river, so that if the stream is to be confined to its banks the banks must be raised. If the banks are not protected the stream will overflow them and flow down the plain in what are known as flood channels. The lower courses of

rivers are marked by bends in the stream, and as the stream exercises more force on the concave bank the result is that the concave bank is worn away, while the convex bank receives more than its share of the mud and sand thrown down by the stream. In course of time the concave side is entirely worn away, and the convex side remains as a "river terrace," marking the former height of the bank of the stream, and

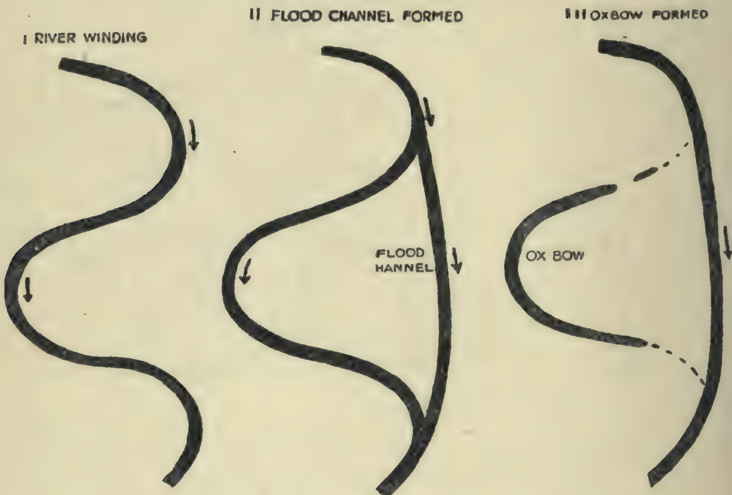

FIG. 52.—Formation of an Ox-bow.

successive alterations in the river course leave behind them an almost flat flood plain.

When a stream has formed complicated curves a flood sometimes causes it to find a more direct course, leaving the curved part as an "ox-bow."

Where the stream enters the sea slowly it forms sand-bars and mud-banks at its mouth, and if there are small tides these banks may become a delta. When the tide has considerable force it may scour out the river mouth and keep the estuary clear at the ebb when the receding tide and river current

act together. When an estuary is closed by a bar and the water inside has practically no current, vegetation grows in the river bed, and by arresting the seaward passage of silt gradually converts the estuary into dry land—*e.g.* Norwich was on an estuary, but the sea mouth was blocked and vegetation has almost turned the estuary into dry land, leaving stretches of water, sometimes below sea-level, called **broads**.

The **Fens** were formed in a somewhat similar manner when it was impossible to confine the rivers entering the Wash to their banks in time of flood. The Bedford Level is a former fen district near Ely, which was partially drained by the Duke of Bedford in the seventeenth century and is now rich agricultural land. As stated before, rivers in limestone districts flow to a certain extent underground; on a clay surface, on the other hand, all the drainage is on the surface, and innumerable pools stand on the surface of the land. If the water collects in a hollow on a bed of clay, vegetation grows at the bottom of the pool and dies. Fresh vegetation grows upon the old, and gradually a peat bog is formed. The peat acts as a sponge, and in times of flood may overflow the sides of the hollow and slide downhill at the rate of a mile or two per hour—*e.g.* Solway Moss, in Dumfries, overflowed in 1771, covering 800 acres with peat varying in depth from 3 feet to 15 feet.

Young rivers are characterized by the steep slopes of their channels from source to mouth, by narrow valleys, and by waterfalls, rapids, and lakes, while their tributaries sometimes enter the main stream in the direction opposite to the general course of the stream. Old streams have gentle slopes and wide valleys; neither waterfalls nor rapids occur except near their sources, while the tributaries enter in the same direction as the main stream. Many English rivers can be found which possess the characteristics of young rivers. In most cases this can be accounted for by "river capture" or by the complications in the drainage of this country introduced by the Great Ice Age.

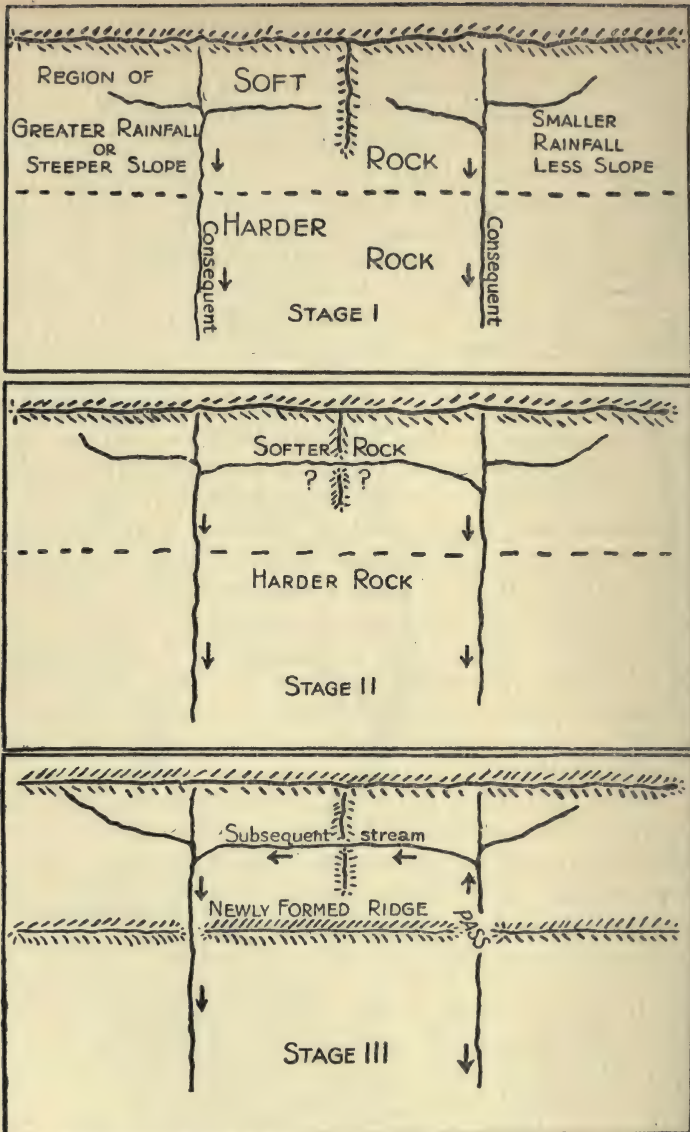

FIG. 53.—The Stages of River Capture.

(1.) River Capture.

The general slope of the surface rocks of England is in a south-easterly direction. Formerly, therefore, all streams may have flowed in a south-easterly direction, but in the course

FIG. 54.—An Imaginary Reconstruction of the Rivers of England, showing the Tributaries which afterwards became Main Streams.

of the streams rocks of different hardnesses were encountered. Thus the tributaries joining the main stream were sometimes so powerful as to cut back the watershed separating the streams, thus joining the two streams. Then the main stream, which offered the easier course, would rob the other stream of its headwaters. This is called "river capture."

It is in this manner that the Yorkshire streams were joined by their tributaries, which now form the main stream of the Ouse. Similarly, the Trent was originally a tributary which wore back its watershed till it joined the Humber. The Severn was probably formed by tributaries of the Thames wearing away the soft Triassic rocks of the Midlands and forming a subsequent river. As a result, escarpments such as the Coteswolds and Chilterns were left stretching from Yorkshire to the south coast. At various points in these escarpments are passes—the so-called "wind gaps"—which were formed when the headwaters of the consequent rivers were lost. Lincoln Gap was formed when the Trent joined the Humber. The Aire Gap across the Pennines was formed when the Ribble captured the headwaters of the Aire, while the activity of a river running into the Solway robbed the Tyne of its headwaters and formed the Tyne Gap. Cases of possible river capture in other rivers are the Thames (the continuation of the Colne valley), rising in Wales; the Clyde, in the north-west of Scotland, may have flowed south-east and been continuous with the Tweed, and the Shannon may have reached the sea at Cork or Kinsale.

The factors which cause the tributaries of one stream to erode more rapidly than those of another, thus leading to the phenomenon of river capture, are (*a*) steeper slope (law of unequal slopes), (*b*) greater rainfall, and (*c*) softer rock.

(2.) The Effect of the Ice Age.

At one time the Polar ice-cap covered the whole of North-western Europe as far south as the latitude of the Bristol Channel. As the climate got colder the mountains of the British Isles were covered with snow, and glaciers were formed. These valley glaciers radiated from the Scottish Highlands and southern uplands, from the Pennines and the Cambrian mountains, while the Welsh mountains contributed, as did those of the east coast of Ireland. As a result the Irish Sea was com-

FIG. 55.—Arctic Glaciers and British Ice Sheets during the Ice Age.

pletely blocked with ice. As the climate became colder still, the Irish Sea area was no longer able to accommodate the Cumbrian glaciers, so the lower parts of the Pennines were overtopped by ice, and ice from Galloway and Cumberland was forced through the Tyne Gap, Stainmoor Forest pass, and the Aire Gap, and there joined the glaciers of the eastern side of the Pennine Chain.

During this time the great Norwegian ice sheet had been growing across what is now the North Sea. Thus the glaciers emerging from the east coasts of Britain were turned to the south. In the case of the Tees the river mouth was blocked by Norwegian and Scottish ice, so the Tees glacier, reinforced as it was by the Cumbrian ice from beyond Stainmoor, turned south and entered the vale of York, leaving on melting three definite terminal moraines to mark different stages in the melting of the ice. These moraines contain rock specimens from Cumberland and the Tees valley, thus leaving evidence of the former courses of the glaciers.

Most of the river mouths of Northern England were blocked by moraine material. Thus after the ice melted the rivers had to find fresh courses to the sea. The bed of the former Mersey is a long way below present sea-level. Lake Windermere and several others in the Lake District were formed by the course of the river channel being blocked by moraine material, which acted as a dam and ponded up the water. Lough Neagh was formed in a similar manner. A chain of lakes stretching from the Tyne to the Trent existed while the river mouths of the east coast were still blocked by ice or moraine matter, though they have now disappeared. The formation of lakes by glaciers damming the courses of rivers is well illustrated by the "parallel roads" of Glen Roy, near Ben Nevis. As the ice melted the lake found outlets at the sides of the valley as soon as these outlets were free from ice. As a result the lake stood at three successive levels, forming in each case a lake beach. Finally, the ice blocking the main mouth of the valley melted and the lake was emptied, leaving the beaches

or "roads" to mark the former levels of the ice-dammed lake. The occurrence of gorges in the courses of such rivers as the Wear at Durham, the Nidd at Knaresborough, and the Yorkshire Derwent at Forge Valley and at Kirkham Abbey, is due to the ordinary course of the rivers having been blocked either by ice or by moraine material, thus causing lakes which have

FIG. 56.—The Gaps and Gorges of North-east England.

found outlets at the lowest points of the surrounding hills, and have deepened the outlets, forming picturesque gorges such as those referred to.

The case of the Yorkshire Derwent is worth considering in detail. The stream rises within a few miles of the sea on the moors north of Scarborough, and before the Ice Age entered

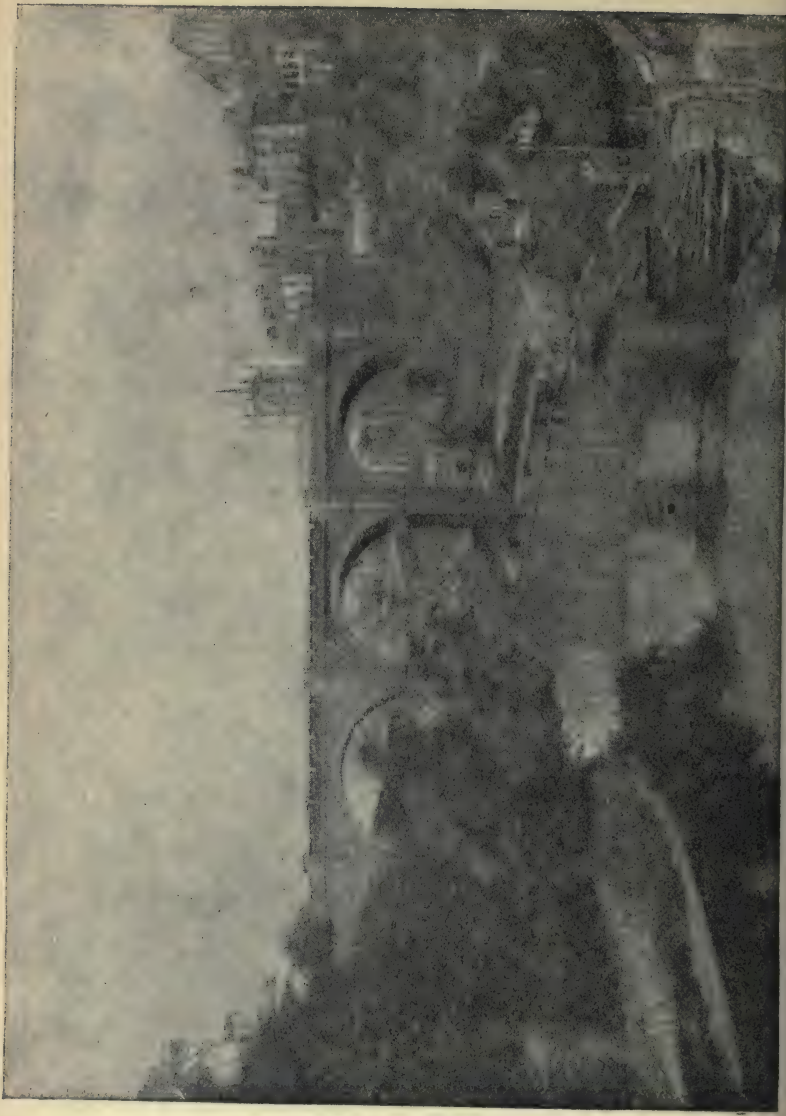

FIG. 57.—The Glacial Gorge at Knaresborough.

the sea somewhere north of that place. During the Ice Age this outlet was filled with boulder clay and ice. The Derwent became a lake which overflowed the hills to the south, cutting the beautiful Forge Valley. The river mouths south of Scarborough were also ice-blocked, so the Derwent proceeded to fill what is now the Vale of Pickering until it was able to over-

FIG. 58.—Pre-glacial River Mouth blocked by Glacial Drift at Sewerby, Bridlington.

flow the hills south of Malton, where in time it carved out a gorge at Kirkham Abbey. Its water, as a result, drains into the Vale of York and enters the Ouse south of Selby.

There are many other gorges, hanging valleys, and other results of glaciation to be found north of latitude 52°, particularly in Scotland, which exhibit the features found in the north-eastern counties. The areas in the British Isles covered

with boulder clay would in many cases, but for the covering of glacial clay, be unfertile. For example, the North York moors can be cultivated up to the highest limit of the drift material, but beyond that limit the vegetation consists of coarse moorland plants ; moreover, the surface cannot be brought under the plough. Thus there is a marked difference in the scenery between regions which are and those which are not covered

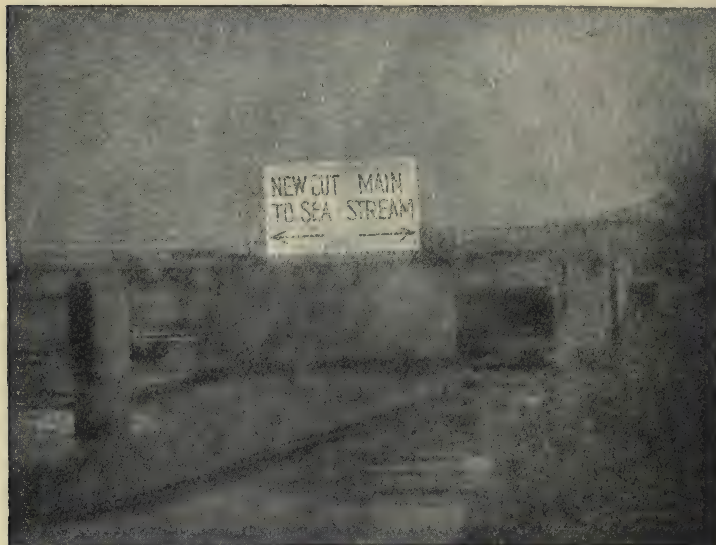

FIG. 59.—Bifurcation of the River Derwent (Yorks).

with drift. Thus a chalk area covered with boulder clay presents an appearance different from that where the chalk has no such mantle. The smooth swelling curves of the Downs, the short herbage, and the subterranean drainage contrast in a marked manner with the wheat and turnip fields of the Wolds, where cultivation is carried almost to the tops of the hill-slopes.

The dried-up beds of the ancient glacier and moraine lakes

of the British Isles are coming more and more under cultivation, though in places their poor system of drainage makes it difficult to replace the rank marsh vegetation with cultivated crops.

The Continental Shelf.

An ancient continent lay to the north-west of the British Isles, and in the south-east lay a sea in which chalk-forming animals lived. Later the north-west continent sank, and the chalk sea-floor was raised above sea-level. The North Atlantic Ocean was formed. What is now the North Sea was probably a series of chalk downs. A little of the ancient north-west continent was left in the north-west of Scotland. Finally, there was a sinking of the Continental Shelf, and the North Sea was formed, while round the present islands numerous submerged forests and peat beds show something of the former extent of the land.

Why are there deep inlets or drowned valleys on the west coasts? Because the west coast is composed of much harder rock than the east coast, so that while the sea has been able to wear down the river mouths on the east coasts as fast as they subsided, in the west the sea has not kept pace with the rate of lowering.

How do we know that the British Isles at one time formed part of the Continent? The physical features of the kingdom correspond to those of the Continent. The rocks of Scotland and North-west Ireland correspond to those of Scandinavia, while those of the Midlands and South-east England are identical with those of France, from the coast at Rouen and Calais to Paris and Burgundy. In the same way the rocks of Cornwall, Devon, South Wales, and South Ireland correspond to those of Brittany, parts of Belgium, and North Germany. Admiralty charts north of Guernsey show a ravine in the sea bed called the Grand Fosse. This is the remains of a great river which formerly ran between England and France. Under the Channel is a continuous bed of gray chalk, filled with clay,

which makes it water-tight. Through this the Channel Tunnel will be made in the same way as the underground tubes in London.

Questions and Exercises.

(1.) Describe briefly the forces at work in the denudation of a river valley. What conditions favour the process? Illustrate your answer by examples of different types of river valleys in the British Empire.

(2.) Describe the relief of either (*a*) the south-western peninsula of England; (*b*) the south-west of Ireland (Munster); or (*c*) the Forth and Clyde basin. Show for the district you select the connection between the relief and the courses of the rivers.

(3.) Describe and explain what you have observed during one of the following: (*a*) a ramble along the banks of a stream to observe the action of running water; (*b*) a visit to a cutting or quarry to study rock formation and arrangement; (*c*) a walk through a limestone or chalk district.

(4.) Account briefly for the existence of the Scilly Isles, "the sands o' Dee," and the indented coast-lines of West Ireland and West Scotland.

(5.) What geographical changes are associated with the following: Lyonesse, the Cinque Ports, Bedford Level, Carse of Gowrie, Old Sarum, and the Weald?

(6.) The rivers of England and Wales may be grouped into three systems. Indicate what physical features constitute the water-partings, and compare the physical features and industries of the three regions thus drained.

(7.) What explanation can you give of the fact that one bank of a river occasionally is sloping while the opposite one is steep-sided? Of what portion of a river valley is this feature most characteristic, and for what reasons?

(8.) The Great Central Plain of Ireland is roughly a parallelogram stretching from the Irish Sea to the Atlantic. Draw a sketch of the plain, making the chief rivers and towns. What

causes the bogs, and how do they affect the prosperity of the country?

(9.) What evidence have we of the former presence of an ice sheet in the north of England?

(10.) Describe the work of a normal river under three heads: (*a*) upper course and erosion; (*b*) middle course and transport; (*c*) lower course and deposition.

(11.) Explain the effects of (*a*) wind and (*b*) frost on land features.

(12.) Explain the character of the scenery, vegetation, and water supply in Great Britain where the rock is (*a*) granite, (*b*) limestone, (*c*) clay. Name districts in which each kind of rock is found.

(13.) Illustrate, with British examples: fenland, watershed, plateau, firth, continental shelf, and sand-bar.

(14.) "Lakes are of many kinds: some contain fresh water, others salt water; some are found at high levels, others at low; while their methods of formation are varied and interesting." Illustrate this by references to particular instances.

(15.) Describe the characteristics and account for the formation of Chesil Beach, Edinburgh Castle Rock, Loch Lomond, and the Thames Gap.

(16.) Describe the history of a glacier.

(17.) Explain the difference between a range of mountains and a group of mountains. Describe briefly the river system in each of the regions you name, pointing out any special feature.

(18.) Compare the geographical conditions affecting the formation of counties south of the Thames with those of the Severn valley.

(19.) What are the chief types of coast found in Great Britain? Give a short description of each type, and indicate a part of the coastline where it occurs.

(20.) What are wind gaps? Explain their occurrence, and the existence of escarpments in the south of England.

(21.) Account for the course of the Trent and for the existence of the Lincoln Gap on the supposition that river capture has occurred.

(22.) Give reasons for believing that Loch Fyne is a fiord. Contrast it with the Firth of Forth.

(23.) Discuss the economic value of rivers to man, and show how their natural conditions may be improved. Give actual instances in support of each point in your answer.

(24.) How are cliffs formed? Under what circumstances can cliffs be formed inland?

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CHAPTER VIII.

NORTHERN ENGLAND.

CLIMATE.

As Northern England is in no place 100 miles from the sea, its climate is equable; but the Pennines, being of considerable height, have a lower average temperature. The Pennine chain has a marked effect on the rainfall, giving heavy rainfall on the western slopes and relative dryness on the east. For the rainfall statistics see Question 10, Chap. I.

PHYSICAL FEATURES.

Examine the atlas map of England, and note the positions of the rivers Tyne, Wear, Tees, Trent, and Ouse, with their tributaries—especially the last, whose tributaries are navigable for considerable distances for barge traffic—*e.g.* the Swale, Ure, Nidd, Wharfe, Aire, Calder, Don, Rye, Derwent, and Hull; the rivers Liddel, Eden, Derwent (Derby and Cumberland), Kent, Lune, Ribble, Mersey, Weaver, and Dee. Note the positions of the chief towns on each river. Insert these in a sketch map of Northern England, and distinguish the heights above 600 feet either by shading or by drawing the 600-foot contour line. In the high land mark the chief peaks—Peel Fell (Cheviots); in the Pennines, Cross Fell, Whernside, Pen-y-gent, Bowfell, Kilhope Fell, Ingleborough, the Peak, Shap Fell; in the Cumbrian block, Skiddaw, Scafell, Helvellyn, Coniston Old Man. Mark also the North York

moors and the wolds. Note particularly the passes through the hilly regions—*e.g.* the Tyne Gap, Aire Gap, Stainmoor Pass, Dunmail Raise; and the chief lakes, Derwentwater, Bassenthwaite, and Thirlmere, Ullswater, Windermere, and

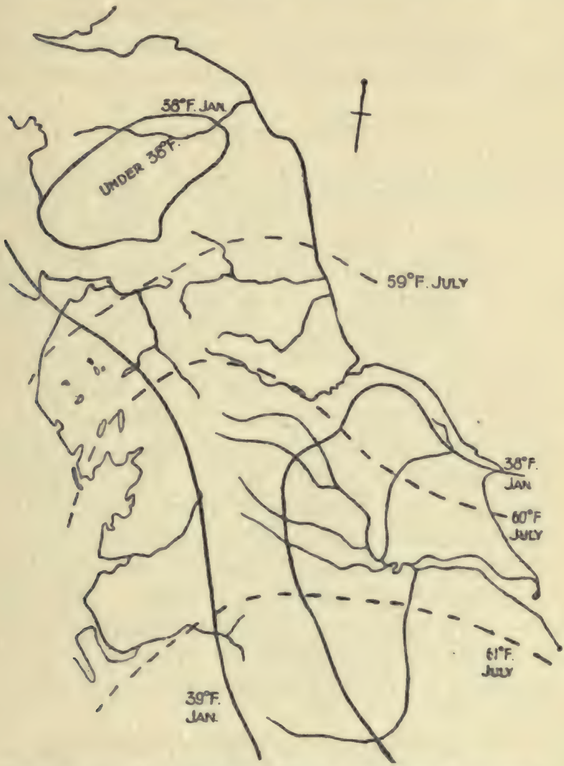

FIG. 60.—Northern England: January and July Isotherms.

Coniston, together with any artificial reservoir you may read about later. Plains and valleys are particularly important—*e.g.* Solway, Northumberland, Durham, Vale of York, Morecambe, and Cheshire plains.

Geological Features.

Enlarge the geological map in the atlas, and from it find of what rock systems each of the chief physical features is composed. From the information about the climate, physical features, and geological structure it is possible to find out the probable areas of agricultural and mineral wealth.

Agriculture.

It must be remembered that, generally speaking, Northern England is covered with boulder clay over the valley regions, and in some places whole districts are covered with glacial clay up to a height of 600 feet above sea-level. Consequently, although the underlying rocks in many cases are unfertile, most of the land under 600 feet is capable of producing crops. The greater rainfall on the west makes it unprofitable to grow wheat west of the Pennines, except in the Eden valley. On the drier parts east of the Pennines, however, wheat is grown generally in the river valleys; though wheat in the past has been less profitable than oats, chiefly because fertilizers are needed and their cost has made it more profitable to import wheat from the undeveloped lands overseas—the U.S.A., South America, Russia, and Canada—than to cultivate it at home. Oats is a profitable crop, and much is grown. Potatoes thrive best on the warp soils of the Ouse-Trent-Humber basin, while the dull, cloudy weather conditions of Durham and Northumberland have led to the extensive cultivation of turnips in those counties.

The Eden valley has an excellent soil and a genial climate, and is naturally a centre of cattle, root, and corn crops. Considerable growing of corn crops as well as natural pasture takes place on the damp lowlands of Lancashire, though here the dominant cotton and coal industries have a greater importance than agriculture.

The upland regions are not cultivated to any great extent

above 600 to 800 feet, and large numbers of sheep graze on the moors, particularly on the mountain limestone area of the Pennines. The largest and most important agricultural valley is the **Vale of York.** Generally speaking, the badly-drained land in the Vale of York below the 100-foot contour line, consisting of boulder clay, produces hay and permanent grass, giving cattle and sheep markets at the river towns of York, Ripon, Malton, Selby, and Thirsk. Northallerton (Battle of the Standard, 1138), on the badly-drained Tees-Ouse water-parting, specializes in dairy produce. It is the collecting station for the co-operative dairy industry of Wensleydale, and makes tarpaulins.

The warp lands of the lower Ouse-Humber and the adjoining district of Holderness produce large quantities of potatoes.

The land between 100 and 600 feet is better suited for the production of oats, wheat, barley, and potatoes than the central parts of the plain. Between these levels patches of magnesian limestone and Triassic rocks come to the surface through the overlying boulder clay, and as both these rocks form fertile and well-drained soils, cereals and market vegetables are easily grown. Local barley and an abundant water supply have given rise to extensive breweries at Tadcaster (Wharfe) and Leeds (Aire), though the present importance of the breweries is probably due to the dense population of the West Riding. The wheat produced in the Vale of York is mixed with foreign grain to obtain fine flour, and milling is carried on at the ports of the Ouse valley: Hull, Goole, Beverley, Selby, York, and Driffield have between them a very considerable flour-milling industry. In the East Riding, on the chalk wolds, intensive sheep-farming—*i.e.* folding sheep on turnip fields—is used as a means of refertilizing the soil for the production of grain crops. The North York moors are barren lands, and sheep-grazing, bee-keeping, and a little lumbering (Ryedale) are the only agricultural occupations.

The Eden, Mersey, and Ribble valleys produce some grain; but as most of the land is under grass, cattle and sheep are

more important than corn crops. The Cheshire plain, with its oak woods, meres, and rich grasslands, specializes in cattle and dairy produce; while the Cumbrian valleys, though producing some oats, have but little importance as anything but cattle and sheep pastures. The coastal plains of Durham and Northumberland produce large quantities of turnips and potatoes, with some cattle, though fresh milk is scarce. The area under cultivation here is small. The Pennines, Cumbrians, and Cheviots feed large numbers of sheep.

Excepting South and East Yorkshire, South Lancashire, and Cheshire, Northern England is not suited for agriculture, though the war has had the effect of improving methods of cultivation, increased the use of artificial manures, broken up pasture, and converted it into arable land, caused large quantities of valuable timber to be felled, introduced co-operative farming, welded farmers and their labourers alike into political and trade union organizations, and extended the upward limits of cultivation in a way not attempted since the Napoleonic wars, when wheat cultivation was extended almost to the 800-foot contour.

Industries of Northern England.

There are four main industrial regions—the north-east coast, the West Riding, South Lancashire, and the Furness-Cumberland coast district.

The North-east Coast.

Agriculture.—The river valleys up to about 600 feet are cultivated chiefly with roots—turnips and potatoes. There is a considerable amount of rough pasture, and hay is gathered. Few cereal crops are grown except on the low lake plains, oats being the chief crop. Cultivation is possible because of the covering of boulder clay left after the Ice Age. The mountain and hill slopes are used as sheep pastures throughout the Pennine chain.

Industry.—The mining of coal, lead, and salt, the making of coke and coal-tar products, the generation of electricity on a large scale, shipbuilding, quarrying, and general engineer-

FIG. 61.—Map of North-east Coast, showing the chief geological features.

ing are the chief industries, while the ports engage in the North Sea fisheries.

The Tyne Valley.

The Upper Tyne runs between the Cheviots and the Northern Pennines. Hexham, at the junction of the North and the South Tyne, commands the Tyne Gap, and is the cattle and sheep market for the upper valleys. The Cheviots give good pastures on the granitic rocks (two sheep per acre), but the coarse

heather lands are relatively unfertile (one sheep per two acres). The limestones and shales and the alluvium of the valleys support prosperous tillage and stock-raising farms throughout the lower levels in Northumberland, though the agricultural produce supplies only a very small proportion of the food needed to sustain the dense population of the northern coalfield. The open moorlands were the original roads in the north country, as the valleys were occupied by flooded marshes or timbered clay flats, the relics of glacial times. The north road into Scotland crossed the Tyne at Corbridge (*Corbovium* of the Romans). As the valleys were drained the main routes gradually descended into the valleys, and Newcastle became the Tyne bridge-town, focussing the north and south traffic between London and Edinburgh, and controlling the trade along the Tyne valley.

Coal outcropping near the river banks led to the early development of the coal-exporting trade (1239, Charter of Henry III.). The local population was scanty, because the farms of Northumberland and Durham in mediæval times were poor, and could not support a dense population. Thus there was no local market for coal. The "sea coal" was shipped coastwise to London, and in 1325 to France. The river banks were well wooded, and since the thirteenth century shipbuilding has been carried on. Iron ores occurred in the Coal Measures and in the Carboniferous or Mountain Limestone of the west, and the smelting of iron dates back to pre-Roman days. The iron ores of Cleveland (27–30 per cent. iron) contain phosphorus, and could not be used for the making of steel. Bessemer's converter for steel manufacture relied on the phosphorus-free Swedish ore (60–68 per cent. iron). In 1879 the Thomas process of adding basic material (limestone) to eliminate the phosphorus was introduced, and made it possible to use the Cleveland ores. The effect of the war has been to hinder the import of iron ore from Sweden and Spain, and as a result old mines have been reopened—especially in West Cumberland, and in the Liassic formation (Oölitic) in Northampton, Leicester, etc.

For instance, it has been found that ore from Skelton (Cleveland) can be used instead of the best Swedish ore. As a result the production of iron ore has increased to four times what it was in pre-war days.

Coal is the chief product and export in the Tyne area. Speaking generally, Northumberland and Durham produce steam coal, while Mid and South-east Durham produce coking coal. The Tyne and Cardiff remain the largest coal-exporting districts in the world, especially in steam coal, which is needed for ships everywhere. The chief rival in coal export is Germany, which exports lignite at a cheaper rate than it can be produced at home, and imports good qualities of British coal for its manufactures. This has in the past interfered with the Tyne's trade, particularly in the Eastern Mediterranean. One great advantage the Tyne possesses is due to the antiquity of its industries, the inherited skill of the people of the district leading to greater and greater specialization of the workers.

British shipping has been largely interfered with by the war, and our shipbuilding industry is now threatened by the U.S.A. The division of labour and the standardization of parts have been carried out so efficiently in the States that the U.S.A. tonnage by the end of 1918 was four times what it was in 1914. When it is remembered that the White Star and allied lines are American-owned though flying the British flag, the existence of out-of-date methods of shipbuilding in Britain shows that we may lose ground in our shipbuilding and in the all-important carrying trade which so largely depends on our building and repairing ships. A special feature of the Tyne trade is the ship-repairing industry.

The chief trade of the Tyne is with Scandinavia, Belgium, Holland, Germany, Egypt, Algeria, and West Africa, sending coal and iron goods, wheat and re-exported foodstuffs, and receiving raw materials, food, drink, and tobacco, and fish and small berries (from Norway) in exchange. Wheat and foodstuffs come to the Tyne from the U.S.A., Russia, Germany, Chile,

Denmark, the East Indies, China, Australia, New Zealand, and Canada. Three per cent. of the wheat imported into the United Kingdom comes to the Tyne. The iron ore is obtained chiefly from Algeria and Spain, but also from Norway, Sweden, France, Chile, Belgium, and Holland. The local advantages of the Tyne are :—(1.) The pitheads are generally at a much higher level than the Tyne banks, and so cheapen the transport of coal to the coal staithes (*e.g.* West Stanley is 700 feet above sea-level). (2.) The high level of the river banks makes it possible to tip the coal directly from the coal trucks into the holds of the "colliers." (3.) From Newburn to the coast there is a lower ledge running along the banks, which has made it possible to construct an electric railway along the river banks to facilitate transport.

Dunstan, where the Team enters the Tyne, is the outlet of the West Durham collieries, and the port for the export of the steel and iron manufactured at Consett. Dunstan, Newcastle, Gateshead, Wallsend, Jarrow, and Shields are the outlets of the coal of Northumberland and Durham, and specialize in shipbuilding, general engineering (Gateshead, North-eastern Railway locomotives), and the making of chemicals (mineral acids, alkalis, explosives, and coal-tar products at South Shields and Birtley). The "slake" at Jarrow forms a natural timber pond, and from there the tide rises twenty feet and floats the barges up the narrow tributary creeks right into the heart of the shipyards and factories. Jarrow manufactures steel as well as iron. At Tynemouth the high banks continuing right to the mouth have facilitated the construction of a breakwater which has made the Tyne one of the safest harbours on the north-east coast. The chemical works depend on local supplies of salt and limestone ; the oil refineries are supplied by Russia, America, and Scotland ; while the Philippines, Russia, India, and tropical Africa are the sources of raw material for the leather and rope manufactures. The ropes are sold to Norwegian and Icelandic fishermen, and to the navies of the North Sea

countries and France. Blyth is an important outlet for Northumberland coal.

The Wear Valley.

The Allendale-Alston-Stanhope district has limestone quarries, and mines producing lead, zinc, fluor-spar, and baryta-spar. The mountain limestone pastures form grazing grounds for large numbers of sheep.

The Middle Wear district has several fairly large towns. Wolsingham uses its coke for iron-smelting. Bishop Auckland (Bishop's Palace), a castle town guarding the exit of Upper Weardale, near the site of Vinovium (modern Binchester), a Roman blockhouse fort, is a thriving market town and railway junction. Spennymoor and Ferryhill are of modern growth, and are the chief towns of the Mid-Durham coke industry, with extensive plants for the production of ammonium sulphate (manure), benzol, and other coal-tar distillation products. The waste gases throughout the district are used to generate electricity. Ferryhill is situated on a gap in the magnesian limestone escarpment, and is an important railway junction controlling the traffic in coke (Wear valley) and magnesian limestone (Raseby Hill and Quarrington) for the blast furnaces of Port Clarence, Cargofleet, and Middlesbrough.

Durham city, near the old North Road (Battle of Neville's Cross, 1346), is the ecclesiastical and educational centre for the Wear valley, and acts as the market centre for the surrounding pit and coke oven villages of Brancepeth (*cf.* Browning), Brandon, Sherburn, and Shincliffe. Durham Castle Rock, enclosed in a loop of the Wear, commands the main route between Scotland and England, and was the centre of the great power of the prince-bishops of Durham, relics of whose existence remain in the cloistered Norman cathedral and the mediæval castle and university. Its control of routes makes it an important railway junction.

The Middle Wear once had village cloth industries

similar to those of the West Riding (*e.g.* Butterby Mill, near Croxdale), but its water-power was small, and there was only a scattered pastoral population from which to draw workers for factories at the time when the West Riding became the woollen centre of England. The West Riding had a large agricultural region from which to obtain labour. The population of the Wear valley was small, and the collieries have absorbed most of the labour attracted into the county. It is remarkable, however, that previous to the war there were few industries employing women in Durham, though with the fuel and electrical resources a woollen industry could exist there. It is doubtful whether any attempt will be made to create a textile industry, though there are an abundance of raw wool, an adequate coal supply, coal-tar products for the making of dyestuffs, a high humidity, and a surplus of female labour, because the West Riding has the advantages of better railway communications and of being so long established as the centre of woollen manufacture. Chester-le-Street shares the prevailing coal, coke, electrical, and chemical industries of Mid-Durham. Houghton-le-Spring exports its coal through Sunderland and the Tyne valley. Sunderland, at the mouth of the Wear, retains its old canvas and sailcloth industry, but is chiefly important for shipbuilding, general engineering, and the export of coal.

The Tees Valley.

The Upper Tees consists of moorland. Barnard Castle, the chief town in the valley track, controls the Stainmoor Pass (stony moor) over the Pennines, and is joined by railway with Bishop Auckland, Durham, and Newcastle, with the Midland Railway at Kirkby Stephen, with the London and North-western Railway at Tebay, as well as with the main North-eastern Railway line at Darlington.

Darlington (river Skerne) is an important engineering centre — rolling stock (N.E.R.), rails, and bridges (*cf.* Stephenson's *Rocket* on the Darlington and Stockton Rail-

way). It is situated about three miles from the Tees (Croft Spa, tar works), but is not accessible from Tees mouth, and so is not a coal-exporting town. Stockton, no longer the chief port of the Tees, is a thriving market town (agricultural and cattle products), having important engineering industries.

Middlesbrough owes its importance to the ironstone deposits of North Yorkshire, the magnesian limestone of the Ferryhill-Cornforth-Quarrington district, to the coke works of the Wear valley, and above all to the fact that it has deep-water communications (artificial harbour) with Spain, Sweden, North Africa, and Greece, from which it obtains iron ore. There are between sixty and seventy blast furnaces at Middlesbrough and Cargofleet, and the iron industry has spread along the Yorkshire coast as far as Skinningrove, where the iron is mined. The pig iron is sent from Middlesbrough to Newcastle and Sheffield, where it is made into iron goods; and to Seaton Carew (West Hartlepool), where it is converted into steel. Middlesbrough supplies the engineering industries of the north-east coast with raw material, though prior to the war Germany and Belgium supplied the greater part of the iron used. The north bank of the Tees pumps brine from the underlying Triassic rocks at Greatham (Cerebos), and much salt is sent to the chemical works on Tyneside, at South Shields, and on the main North-eastern Railway line between Ferryhill and Gateshead. Unlike most British ports, Middlesbrough has exports three times as valuable as its imports, and the town has not developed an entrepôt trade. Though coal-loading cranes have been installed, Middlesbrough does not export much coal.

The making of rails and general engineering is the chief industry after smelting. Saltburn and Redcar are seaside watering-places within easy reach of the Tees towns. West Hartlepool is the most important pit-prop (Sweden) importing port; it has a considerable shipbuilding and engineering industry, a steel works, exports coal, and supplies Mid and South-east Durham with fish.

The Yorkshire Coast.

Notice the geological formation of the Yorkshire coast in your geological map. From north to south the rocks exposed are Triassic sands, Liassic limestone, sandstones, and shales, Oölitic rocks with Kimmeridge or Oxford clay, and chalk from Flamborough to Bridlington, and south of Bridlington boulder clay. The result of the retreat of the Norwegian ice sheet was to leave pre-glacial rivers blocked with boulder clay, so that recently formed ravines are now in existence giving a series of small but deep gorges running down to the sea. The Whitby Esk with its gorges, the Derwent with its lovely gorge through Forge Valley, numerous tiny ravines —*e.g.* Hayburn and Cloughton Wykes, Ramsdale Valley at Scarborough, and Filey Ravine—give an indescribable beauty to the coastal edges of the North York moors.

The Triassic rocks give magnificent sands from Saltburn to Middlesbrough. From Saltburn to Scarborough the Lias and Oölite give a series of headlands and rocky bays dangerous as harbours, but sheltering picturesque fishing villages. Scarborough, with its castle rock separated by a fault from the plateau inland, is a fishing port which has developed a very considerable summer resort traffic. The cliffs at Gristhorpe overhanging the more easily eroded Kimmeridge clay, and the "Brig," an outcrop of rock at Filey forming a natural groin, and giving pools, such as the Emperor's Bath, at all states of the tide, contrast with a five-mile stretch of perfectly sandy beach within a few hundred yards. The cavernous chalk cliffs in the Flamborough district, with a twenty-mile beach ending in the mud flat of Spurn Head, complete one of the most varied pieces of coastal scenery in the British Isles. The result is that the fishing villages have developed into summer resorts at Redcar, Saltburn, Whitby, Robin Hood's Bay, Scarborough, Filey, Bridlington, Hornsea, and Withernsea, connected from Bridlington to Middlesbrough by rail. Hornsea and Withernsea are practically suburbs of Hull.

The Basin of the Ouse.

Construct a large-scale map of the geological features of the area of the Yorkshire rivers, showing areas above 600 feet.

The Dales.—The tributaries Swale, Wharfe, Ure, Nidd, and Aire flow through a series of dales with green sheep pastures on the limestone rocks and heather moors on the sandstones, tillage being confined to the alluvial stretches near the river banks. Some lead is still mined in North-west Yorkshire, and mountain limestone is quarried in the upper parts of the dales. Commanding the dales are the cattle-market towns of Richmond (Swale), Knaresborough (Nidd), Masham (Ure), Ripon (Ure), the outpost of Scottish missionary effort, near which the monks of St. Mary's Abbey, York, founded the great Fountains Abbey, which provided the town with wool for the mediæval cloth industry, for which, with the manufacture of harness and spurs, Ripon was famous, Ilkley (near Bolton Abbey on the Wharfe), and Skipton, commanding the Aire Gap and the Midland Railway main line from London through Settle to Carlisle. These towns are ancient centres of interchange between the Vale of York and the dales, which grew up in the shelter of feudal castles placed there to keep in order the unruly inhabitants of Northern England and to act as protection against Scottish invaders. Wensleydale is an advanced agricultural district, as it is served by the cross-Pennine line from Northallerton to Hawes and thence to the Midland Railway main line. The healthy conditions and the mineral springs of the most picturesque parts of the Mountain Limestone and Sandstone formations of the dales area have given rise to a number of inland health resorts, of which the chief is Harrogate, though Ripon, Pateley Bridge, Knaresborough, and Ilkley can be regarded as holiday and health resorts.

The Vale of Pickering.

The Rye and the Upper Derwent have given rise to country market villages at the places where the streams run into the

Vale of Pickering (*cf.* Lake Pickering of glacial times), at Helmsley (Rievaulx Abbey), Kirkby Moorside, Pickering (castle), and Seamer (castle and horse fair). The central market town of the vale is Malton, commanding the gorge (Castle Howard to Kirkham Abbey) through which the Derwent enters the Vale of York. Cattle and sheep are the chief productions of the Vale of Pickering, though the marshy lake plain is producing increasing quantities of corn and root crops. Malton shares in the prosperity of the northern wold farms from Kirkham to Filey, and is a centre for the training of race-horses.

The Whitby Esk.

This river connects a series of small villages which have tillage for corn and root crops on the scanty alluvial stretches near the river and sheep pastures on the moors on each side of the valley. Whitby, the nearest port to the Dogger Bank, is the natural market, and has a short holiday season in August and September. Its ancient tradition, dating back from the time of Captain Cook, has left it an important ship-owning town, though, owing to the poverty of its hinterland, it is neither a great fishing port nor an important harbour. Its local jet industry has been killed by changes of fashion.

The Middle Ouse and the Vale of York.

This is a purely agricultural region, with rich farms on the Triassic rocks, with thriving corn, cattle, and sheep markets at Thirsk, Ripon, Knaresborough, and Wetherby, which are connected by rail to the two chief Yorkshire markets, York and Leeds. The Ouse valley has a valuable surface soil, with ridges of moraine material crossing from west to east. York is situated where the Ouse breaks through one of these ridges, and this has controlled communications across the Ouse valley since Roman times (Roman road : Tadcaster, York, Stamford Bridge, Flamborough). York shares with Hull the agricultural trade for North and East Yorkshire, being connected

by rail with Malton (Vale of Pickering) and Market Weighton (Wolds).

The settlement of the Ouse basin appears to have been done chiefly by Anglian and Danish settlers, religious bodies, and much later by Dutch, Belgian, and French immigrants. Thus the place-names give some indication of the history of settlement. The Saxons and Danes left many Burtons and Boltons, Kirkbys, Thwaites, Thorpes, Hams, and Fords; the religious orders, large monastic establishments at Rievaulx, Bylands Fountains, Bolton, Kirkstall, York, Selby, Beverley, Bridlington, and hundreds of smaller ones, each of which was a centre of agricultural industry.

York being the lowest ford and bridge town on the Ouse, was the chief town throughout the Middle Ages, and became and remained the ecclesiastical and commercial capital when agriculture was the only really important industry. It gathered to itself the sole right of export of the staple products of mediæval trade—wool, lead, and glass. It must be remembered that the journey from York to Holland, the Hanse towns of Germany, and France was less perilous than the journey to London; besides which there was no need to trade much with London, which was a competitor in the wool trade. As a result the Flemish trade was a source of tremendous wealth, and York shared in the fish trade of the North Sea, the fish being landed on the quays of the city.

The confluence of the Foss with the Ouse gave York a naturally strong position. It was adopted as a Roman fort (*Eboracum*). The Danes added a new town on the hill on the west bank of the river (*Eoforwic*). The Normans demolished its wooden forts and began the construction of stone walls. Edward III., the father of English commerce with Flanders, completed its moats, and it became one of the chief mediæval cities engaged in those small industries which were necessary in the life of a city in mediæval times. The Church fostered commerce by holding fairs or "feasts" throughout the country on saints' days. The early mystery

play, the forerunner of modern drama, was encouraged. The city had its educational establishments from the time of Alcuin, and York became the most civilized town in northern England.

For its commerce, however, it depended on an agricultural hinterland, and as the coalfields attracted the bulk of the population into the south-west of the county, the cathedral town was left far behind. The making of a small lock just below the town, inadequate to the needs of modern ships, finally destroyed York's prosperous West Indian trade less than a hundred years ago, and the only thing that remains of York's river-port trade is the barge traffic in coal and flour. A larger lock, the deepening of the Ouse by dredging or by canalization, would have allowed York to retain some of its oversea trade. Flour-milling and confectionery-making still remain two of the chief industries, and the control over routes exercised by the site causes York to be one of the chief railway and military centres of the north of England. (*Cf.* York and Durham.)

The agriculture carried on in the Lower Ouse owes much to the Dutch settlers, who drained the marshes and improved the land by warping—*i.e.* growing reeds in the marshes until they have accumulated sufficient mud during high tides to make it possible to enclose and drain the mud marshes. This, and the making of canals and drainage dykes, have been carried on for centuries. In the time of Charles I., Cornelius Vermuyden, after draining the fens, gave his attention to the Aire-Don-Went river deltas at the entrance to the Humber, and drained large areas of what is now magnificent arable land. The admixture of Dutch and Belgians (Vandravarts, etc.) has improved the agriculture of South Yorkshire enormously. Market Weighton, Beverley, Howden, Selby, Goole, Snaith, Thorne, and Doncaster have busy little markets like those of Flanders (*cf.* Howden and Poperinghe, Snaith and Steenwerck, Selby and Estaires, and apart from the hedgerows and slight differences in town planning, you find

the same type of population, similar methods of cultivation, similar crops, and similar landscape).

This extremely fertile district, including the Humber and the lower valleys of the Hull, Derwent, Wharfe, Ouse, Aire, Went, Don, Idle, and Axholme, is probably destined to cradle a population as dense as that of South Lancashire and a city almost as big as Liverpool, owing to the fact that it is underlaid by an enormous area of undeveloped coal. Unlike the West Riding woollen district and the Barnsley-Sheffield area, it is very fertile, and this will be one of the chief factors in causing a tremendous increase of population within the next few years.

The York Wolds Area and Holderness.

This district, with sheep and corn farms on the lowlands, has given rise to collecting markets at Beverley, Driffield, and Market Weighton, with a central market at Hull and a considerable trade with Leeds, Pontefract, and Sheffield. Similar farm lands in the north of the Lincoln wolds have given markets at Brigg, Market Rasen, and Louth, with central markets at Grimsby and Lincoln, and trade with Sheffield, Chesterfield, Worksop, and the Mansfield-Nottingham districts. The river port of Goole is likely to develop into a very important place, railway, river, and canal communications being easily constructed. The river ports of the Humber area have milling centres at Selby, York, Brigg, and Doncaster; cattle cake, soap, and chemical industries depending on vegetable oils, at Selby, Hull, and Leeds. This trade depends largely on imported beans, nuts, and other oil stuffs. Flax cultivation for the West Riding textile industries is being developed, owing to the war having cut off the supply of fibres from Russia. The flax cultivation will in all probability be continued, as scientific methods of treating the fibre are shown to farmers by the staff of the Agricultural Department of Leeds University. The oil industries—soap, cattle cake, margarine, and the making of artificial manures—will become

increasingly important as the tropical regions are made to yield greater quantities of oil-containing nuts. Beverley, Selby, Grimsby, and Hull build trawlers and cargo boats, and shipbuilding will probably develop at Scunthorpe and Goole.

The Great Yorkshire Coalfield.

The Aire valley is the northern limit of the woollen industry. Keighley specializes in textile machinery. Bradford is the centre of woollen cloth manufacture, and has silk, velvet, and plush industries. Saltaire, near Bradford, is the model factory town of Sir T. Salt, and makes alpaca. **Leeds,** with easy communications down the Aire valley and across the Pennines by the Aire Gap, and situated on the northern edge of the Yorkshire coalfield, is the focus of the dales of the West Riding, and became the wool-collecting market before the age of manufacture. It probably owes something to its monastery at Kirkstall Abbey, which produced wool fleece and smelted iron. **It is now the greatest clothing town in the world,** and owes much to its alien immigrants—Flemings in the fifteenth and Jews in the nineteenth century. Iron in its Coal Measures gave rise to iron-manufacturing in early times. Modern science, using the basic Bessemer process, has enabled it to maintain a steel industry though it is not a port. Leeds is on the south of sandstone moorland, with a pure water supply. This has assisted the development of its leather and dyeing industries.

The valley of the Calder and the Barnsley district contain most of the remaining textile-manufacturing towns. Halifax, like Leeds, owes much to the settlement of foreign artisans (1489). It specializes in light worsteds, baizes, and carpets. Huddersfield, on the Colne, a tributary of the Calder, specializes in high-class cloths. Dewsbury and Batley make heavy fabrics—*e.g.* blankets and shoddy. Castleford, near the confluence of the Aire and Calder, is a colliery town which makes glass. Pontefract and Knottingley have collieries, with iron

and chemical industries. Wakefield and Barnsley, the great colliery centres, share in the textile trade. The importance of the Barnsley district is growing, and the mushroom growth of colliery villages towards Doncaster is worthy of notice. Hickleton, Barmborough, and Bolton-on-Dearne have been converted from mere hamlets into towns of considerable size. As the underlying coal seams to the south-east are opened out, the river Went will become of greater importance, the Don valley will be a string of important towns, and Goole will be a great coal-exporting port, and its position as the focal point of the Ouse will give it a tremendous trade in distributing imports.

The Don valley is one of the most important industrial regions in the British Isles. Sheffield, the largest town in Yorkshire, is situated in a hollow below the junction of the headstreams of the Don. Originally it became important because of the iron ore and timber supplies of the neighbourhood, and the fact that the Millstone Grit of the hills immediately to the west of the town was of a very fine texture specially suitable for grindstones. To its iron-smelting was added the making of sharp iron instruments. Improvement in the quality of Sheffield cutlery followed the discovery by Huntsman in 1740 of the method of making "crucible" steel by the cementation process. In 1858 the Bessemer process increased the amount of steel available, though the best Swedish material was still used. Specially hard steels have given Sheffield armour-plate industries (*e.g.* ammunition, battleship plates, and heavy guns). At present the pig iron is largely obtained from the north-east coast, but the special Sheffield industry is increasing, and its reputation is world-wide, so that it is likely that pig iron will be obtained to some extent from local furnaces when the new coalfields are opened.

The iron and steel industry is not confined to Sheffield, but stretches down the Don valley to Rotherham, which has brass foundries as well as coal, iron, and engineering industries. Mexborough is mainly a colliery town, and Doncaster, where

the North Road and railway cross the river, makes rolling stock for the Great Northern Railway, and is an important junction.

Notice the focal position of Doncaster, with railways radiating to Sheffield, and thence to Manchester, Barnsley, Wakefield, Leeds, and Bradford; Selby, and thence to York and Newcastle, Goole and Hull, Scunthorpe and Grimsby; Gainsborough, and Lincoln to Boston, Worksop, Retford, and London. Doncaster's position, together with the fact that collieries are rapidly growing round it, will make it a very large town with large iron and steel industries, a great coal trade, and possible industries dependent on coal-tar products. It may also become an agricultural market of importance. (Notice that brewing and flour-milling are carried on at Tadcaster, Sherburn, Whitley Bridge, Askern, and Doncaster, at the junction of the eastern agricultural districts and the densely populated collieries.)

Thorne is at present an agricultural town, but coal shafts are being sunk in the neighbourhood. The land between Goole, where the Aire reaches the Humber, and Thorne (Don)—Thorne Waste—and between Thorne and the Thorne river—Hatfield Moors—is covered with valuable peat moors which are used for the supply of moss litter. Peat is being used more and more in gas engines, and as ammonium sulphate can be obtained from it, will probably be used as a source of manure.

An abundant water supply is an important factor in the development of an industrial region, and there is a danger that a serious shortage may hinder the development of the Don area. Selby very wisely has provided an abundant supply in case of a large increase in its population. Leeds and Bradford are rivals for the control of the waters of the Upper Wharfe and Upper Aire, and Leeds is looking for fresh supplies. Mid-Durham, with a population approaching 400,000, is faced with a similar difficulty, and costly engineering works will be necessary before the new industrial areas receive sufficient supplies for their industrial and domestic needs.

The coalfield extends southwards from Sheffield, and Doncaster and Chesterfield produce coal and iron, Mansfield coal and textiles (lace). Bawtry is an important colliery, Worksop makes iron goods, while Nottingham marks the southern extremity of the great coalfield.

The Lias yields iron ore on the western edges of the Lincoln heights and Leicester uplands, and has given rise to iron-smelting and allied industries at Scunthorpe (the Frodingham ore outcrops at the surface), Gainsborough (machinery), Newark (machinery), Grantham, Loughborough, Leicester (textile machinery), and Lincoln (agricultural machinery). Lincolnshire, in many respects one of the foremost agricultural counties, is gradually becoming industrial as the coalfield is being opened out, so that it is not improbable that the corn, sheep, and cattle markets of Brigg, Market Rasen, Louth, and Sleaford, with their port at Boston in the Wash, may become important industrial and commercial centres.

The ports at present are Hull and Grimsby (see BRITISH PORTS, p. 128), but Immingham, with its up-to-date coal appliances and docks, and Boston, though less suited for ocean-going shipping, may become important. Lincoln city, where the Witham cuts through the Lincoln heights, was originally a Roman station on the great north route along the heights to Ferriby, and continued north of the Humber along the Yorkshire wolds. Its marshes were drained, and it became in the Middle Ages a typical "gap" town, controlling east and west trade along the Witham, and, like so many British ecclesiastical centres, a focal point, some distance from the coast-line (*cf.* York, Norwich, Winchester, Canterbury, and St. Davids). It remains an important market town and railway centre, being on the main Great Eastern (London, Cambridge, Ely) route. A number of seaside resorts for the people of the Midlands and South Yorkshire have grown up on the Lincoln coast at Cleethorpes, Sutton, and Skegness.

The Canals of Northern England.

About 1740 it was only with great difficulty that goods could be transported. Pack-horses were largely used, and such things as Cheshire cheese and Derbyshire lead were sent down the Trent to Hull by river because the roads to the Mersey mouth were so poor. Little towns sprang up wherever the rivers shallowed—*e.g.* Beverley, Selby, Boroughbridge, and Bawtry The importance of these river routes grew until it became necessary to join the manufacturing centres or hinterlands to the ports.

The great era of canal building was from 1750 to 1820. When the construction of railways began, the canal companies tried to crush them, but failed ; and during the last hundred years the canal system has declined and is falling into disuse. In some cases the railways bought the canals in order to get rid of competition.

The Lancashire canals are described in the chapter on Textiles, but there are several on the other side of the Pennines worthy of notice. In 1121 the Foss Dyke was constructed, connecting Lincoln to the Trent ; in 1462 the Bishop's Dyke was made, from the magnesian limestone quarries at Sherburn in South Yorkshire to the Ouse at Cawood, for transporting stone for the construction of the cathedral church at York and for the repair of the city walls.

In 1699 the Aire and Calder navigation was begun, linking up Leeds, Castleford, Barnsley, Selby, and Goole. This still contributes to the wealth of Goole, which is either the sixth or seventh most important port, with canal, river, and railway communications inland. Though its docks are not yet suitable for the largest vessels, it has a great European and coastwise trade in grain and provisions, wool and coal.

The Leeds and Liverpool Canal was constructed between 1775 and 1816. Though it connects Leeds, Bradford, Keighley, and Skipton (through the Aire Gap) with Wigan and Liverpool,

its 104 locks make working slow, and it cannot compete successfully with the railways. Its upkeep is expensive, and there is very little cross-Pennine trade. Similar considerations made the Rochdale Canal, which connects Manchester with Halifax and Huddersfield through 242 locks, unprofitable.

Take a relief map of Europe, and from it you will find that the flatness of the land determines the importance of canals. Thus you find the French rivers connected by canals to the Rhine valley, while Holland and the North German plain are particularly suitable for canal construction. Except in the plains England cannot use canals with profit, though many of the really useful canals are neglected. The Midland canals in the hardware, pottery, and coal districts are largely used, because water transport is either safer or cheaper than railway transport for pottery, coal, and iron, which are bulky in proportion to their value.

The Eden Valley.

This valley is formed of red sandstone which has weathered into very rich soil (corn, cattle, sheep, and potatoes), and is very picturesque. It is well wooded. (Penrith is a tourist centre.) It opens out into the Solway plain, of which the market centre is Carlisle, the position of which has always been important, commanding as it does the west coast route into Scotland. Carlisle, the *Luguvallium* of Roman times, a shrine of Mercury, and near the end of Hadrian's Wall, is the focus of the Solway ports. Sacked by the Danes in 872, its castle and bishopric were restored by William Rufus. The Great War made it necessary to establish munition works throughout the country, and Carlisle's railway communications with the Tyne, the Forth, the Clyde, and Lancashire made it one of the most suitable places for the manufacture of explosives and shells. Its remoteness from the east coast made it relatively safe from raiding enemy cruisers and Zeppelins. As a result it became, with Gretna, a great industrial centre,

joined to the Cumberland coalfield by the Whitehaven-Cockermouth line, and to the Tyne by the North-eastern Railway. Its pre-war manufactures were cottons, woollens and linens, leather, and biscuits. It is the junction of two main railway systems: the Midland—Glasgow and South-western and the London and North-western—Caledonian systems. It is joined to Edinburgh by the North British Railway.

The Lake District.

The Lake District is a dome of old hard rock, and was in the past a volcanic centre, of which the stumps or necks of the old volcanoes form the core of the Cumbrian hills. Its height and position on the west coast give it the greatest rainfall in England, and little soil remains on the bare hillsides. The old glaciers which radiated from the peaks left hollows in the valleys now occupied by beautiful lakes, which are the centre of interest for tourists visiting the lakes. Thirlmere supplies Manchester with water, and other lakes may eventually be used as natural reservoirs—*e.g.* Manchester proposes to make Haweswater into a reservoir. The formation of a delta by the Greta entering a large lake in the valley of the Derwent has led to the creation of two distinct lakes—Bassenthwaite and Derwentwater. Notice the position of Keswick, controlling the route between the lakes and up the Greta valley. Keswick became the centre for the making of lead pencils because of the nearness of the Borrowdale graphite, and retains the industry, importing its graphite from Ceylon and its cedar from Florida. Kendal, the only other town of any size in the Lake District, still manufactures some woollens, but its lack of coal is not compensated by its position as a sheep centre. The Lake District owes its importance to the beauty of its scenery and to its being a great literary shrine (*cf.* Ruskin and Wordsworth). The well-timbered valleys give the chief economic value to the district, though scientific afforestation is not carried on on a large scale.

FIG. 62.—Map of the Lake District.

The Cumberland-Westmorland-Furness Coast.

Silloth is the port of Carlisle. Maryport, Workington, and Whitehaven are the Cumberland coal ports, supplying Barrow, the Isle of Man, and Ireland with coal. The better coal and coke for the blast furnaces of the Furness district, come largely from Durham. Cockermouth shares the iron industry of Workington. The Furness district, with the towns of Barrow, Carnforth, and Ulverston, depends to a great extent on the very pure iron ore (hæmatite) found in the neighbourhood. Iron-mining was extended during the war, and Barrow has accordingly become one of the leading places for the building of warships and manufacture of ordnance. The Lake District has large stretches suitable for gun trials. Barrow owes a good deal to the depth of water between Walney and the mainland.

The Lancashire-Cheshire Plain.

The Ice Age left the Lancashire-Cheshire valleys filled with boulder clay and with innumerable marshes and bogs, and the rivers had to begin again the excavation of valleys. The remoteness of the region from the civilization of the Midlands and Southern England made it a refuge for the Britons, the people of Strathclyde, and at a later period for the Catholic adherents of the Pilgrimage of Grace (1535). Until the Industrial Revolution, the only towns of importance were Chester, the Dee port and seat of border earldoms; Manchester, which made woollens and afterwards Manchester "cottons"—a linen and wool cloth; Liverpool, a small port on the Mersey; and Lancaster, the castle-bridge town of the Lune, with its agricultural market.

The Industrial Revolution, with its demand for coal, the immigration of foreign artisans, and the lure of high wages paid in factories, altered Lancashire's position, until it became the most densely-populated area in the United Kingdom.

To understand the sacrifice by which Lancashire obtained this result it is necessary to read about life in the early factories —how workhouse children were herded together, carried to Lancashire, and apprenticed to the factories without being able to choose for themselves; how the factory owners bribed the local workhouse officials to get cheap child labour; how these children, some of them only six years old, were driven from bed to work sixteen or eighteen hours a day; how their beds never grew cold, because as they left them another shift of tired children took their places; how these tired youngsters were under the control of overseers with whips; how the overcrowding of factory districts ruined the physical and moral well-being of generations; and how the members of Parliament interested in cotton mills fought against the introduction of schools and against the shortening of the hours of labour.

The children of Lancashire still have a system by which they work half the day in the factory and the other half in school; and it is noteworthy that the Education Act of Mr. Fisher, for abolishing the half-time system and for allowing children between the ages of fourteen and eighteen to attend day continuation schools, was blocked by the Lancashire group of M.P.'s until the main points of the continuation school system were abandoned. The argument against the continuation school system was that unless Lancashire had juvenile cheap labour the cotton industry could not be carried on successfully.

We see, therefore, that it was not only the existence together of the Mersey estuary, the South Lancashire coalfield, and a high relative humidity that made Lancashire the chief cotton-manufacturing centre of the world. Its eminence was also obtained by the sacrifice of the youth and happiness of generations of cotton operatives. (Read the history of the Factory Acts.)

The Lune valley is bridged at Lancaster, which manufactures linoleum, oilcloth, and furniture, and is the sheep and

cattle market town for the valley. Morecambe is a pleasure resort. Heysham is the Midland Railway port for the Isle of Man and Ireland. Fleetwood is the London and North-western port for Ireland and the Isle of Man.

The Ribble, with Preston, Clitheroe, Burnley, Accrington, and Colne, is connected with the West Riding of Yorkshire by the Aire Gap, the headwaters of the Aire having been captured by the Ribble. Preston (L. & N.-W. R.), the port, is a cotton manufacturing town, with soap works and oil refineries. Blackburn, Burnley, Clitheroe, and Darwen (paper) are cotton towns with excellent communications with Bradford and Leeds. The woollen and cotton manufacturing areas overlap at Burnley, Colne, and Nelson.

The Mersey is still more important. Manchester-Salford, at the focal position of the tributaries of the Mersey, early developed textile industries, and is the natural market of South Lancashire. The towns feeding Manchester are Bolton (spinning), Bury (cotton and wool), Rochdale (cotton and wool), Oldham (fine "counts"), Stalybridge, Hyde (felt and cotton), and Glossop (silk), at the entrances to the tributary valleys where the old water-power industry was situated (*cf.* Leeds). These towns have dammed the streams to form reservoirs to feed the boilers of the mills and the dyeworks, and cotton-spinning, weaving, and dyeing are carried on at each place.

Coal is mined in the Wigan-Manchester district, and at Oldham and Ashton. Wigan and Leigh, the coal centre, has cotton and iron industries. **Manchester** is the **greatest cotton market of the world**, and makes clothes and dress fabrics (*cf.* Leeds). Warrington makes cotton, wire, machinery, soap, and chemicals. Liverpool, the second port of the kingdom, has flour mills, oil and sugar refineries, tobacco works, and controls shipping trade in all parts of the world. Birkenhead has developed shipbuilding and chemical industries.

Lancashire's dense population has made the following health resorts important: Blackpool, Douglas, Southport, Dublin,

and Llandudno, while numerous small seaside villages have developed a summer season trade between Bangor and Morecambe Bay. St. Helens produces coal, glass, and chemicals (alkali), and Widnes and Runcorn share its alkali manufacture. Darwen and Chorley make paper from cotton rags.

The south of Lancashire has always been badly drained, but during the Great War German prisoners were employed in drainage work. The Glazebrook, a tributary of the Mersey, and the Douglas, have been partly cleaned ; in Cheshire, the Birkett and its tributaries in the Wirral Peninsula are being deepened, while the Frodisham and Ince marshes are being drained, with the result that a considerable area of arable land is being added to South Lancashire.

Cheshire has the same underlying sandstone as South-east Durham. The Trias, which outcrops in many places, gives splendid cattle pasture (Cheshire cheese). Fruit is also cultivated. The glacial clay produces cattle pasture, and is cultivated to produce turnips and potatoes rather than corn crops. Parts are well timbered (*e.g.* Delamere Forest), and many small lakes and meres relieve the monotony of the scenery. Congleton and Macclesfield (silk) belong industrially to the Manchester-Derby area. The Triassic sandstone is made to yield brine at the salt towns of Sandbach, Nantwich, Middlewich, and Northwich, which supply the chemical works of Lancashire (alkali) and the Potteries (glazing).

Crewe, equally central for the North Wales, Liverpool, Manchester, Stafford (and London), Shrewsbury (and South Wales), Birmingham lines, has become a great railway junction (L. & N.-W.R.), and manufactures locomotives. Chester, the ancient Dee port, commands the North Wales route. It was the centre of Roman power against the North Welsh. The Dee, however, has silted up, and ships have grown larger, so that the river is no longer navigable for ocean-going vessels.

Questions and Exercises.

(1.) Describe the main physical features of Yorkshire, and give the exact position of its important towns. Account for the great growth of manufacturing industries in the county.

(2.) Describe the exact position of the two chief gaps in the Pennines, pointing out what river valleys they connect. What is the industrial importance of the routes opened by them?

(3.) Draw a sketch map of the six northern counties of England to show the positions of the chief hills and rivers. Mark Leeds, Carlisle, Preston, Sheffield, and Manchester.

(4.) Where is the Plain of York? How is it bounded? Describe its river system. What main lines of railway cross it? Name its chief industries, and account for their importance.

(5.) Enumerate the circumstances which have led to the development of the seaports of the north of England.

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CHAPTER IX.

THE EASTERN COUNTIES.

CLIMATE.

CONSTRUCT a map showing July and January isotherms and rainfall. This shows that the area has a much smaller average rainfall than any other part of the kingdom, and that there are considerable differences between winter and summer temperatures—*e.g.* in Cambridge the coldest day temperature in 1917 (February) was 27° F., the coldest night 11°; the warmest days (June and July) 90°, and the warmest night 62°. The climate is more extreme than that of any other part of the British Isles. The average bright sunshine is four to five hours per day, whereas Sligo, on the west of Ireland, has only from three to three and a half hours daily. This makes a difference of over 365 hours of sunshine in a year, and is the reason why the Eastern Counties are better able to produce wheat and other corn crops than places in the west. The winter frosts help to break up the soil and assist tillage.

PHYSICAL FEATURES AND THE PEOPLE.

Refer to a geological map, but remember that large stretches of the Eastern Counties are covered with boulder clay and drift and river soils. The geological map shows that the underlying rocks consist of Oölite and Chalk. These dip towards the east or south-east, so that their escarpments or western edges form a series of hills. The Oölite forms the

Lincoln Edge, the Leicester and Northampton uplands, and the Coteswold Hills; the Chalk, beginning at Flamborough, forms the Yorkshire Wolds, Lincoln Wolds, the East Anglian heights, and Chiltern Hills, and continues south of the Thames as the North and South Downs.

Except on the hills, the whole of South-east England is covered with boulder clay or with newer rocks which have weathered into rich soils. The low-lying plains make drainage poor, and the coastal regions of the great estuaries (the Humber, Wash, Waveney, Yare, Orwell, Colne, Chelmer, Crouch, Roach, Thames, and Medway) are marshy mud-flats. The conversion of these mud-flats into dry land suitable for farming is carried on constantly. The Fens, a marshy district below high-tide level, has been in great part reclaimed by using the methods of the Dutch and sea walls, drainage dykes, and canals—*e.g.* the Bedford Level, windmills, and wind-pumps are characteristic of the low-lying areas.

Tidal movement partially closed the Humber (Spurn Point and Sunk Island), and erected a bar across the mouth of the Yare, making the estuary an inland lake, which has been silted up, forming the Norfolk Broads, and making Norwich no longer a seaport. (Hornsea Mere, the largest lake in Yorkshire, presents an appearance similar to that of the Broads.) The sea, however, has destroyed much of the soft cliffs of the east coast area, and whole towns have disappeared in the sea (*e.g.* Ravenspur and many smaller villages on the coasts of Holderness, Lincoln, Norfolk, and Suffolk), leaving very few channels suitable for vessels of deep draught between the Thames and the Humber. As a result there are no ports of any considerable size between London and Grimsby.

Parts of the coast have good stretches of sandy beach, giving rise to numerous watering-places—*e.g.* Sutton, Maplethorpe, Skegness, Cromer, Yarmouth, Lowestoft, Felixstowe, Walton, and Clacton. Southend on the Thames (mud beach) owes its popularity to its good railway service with East London.

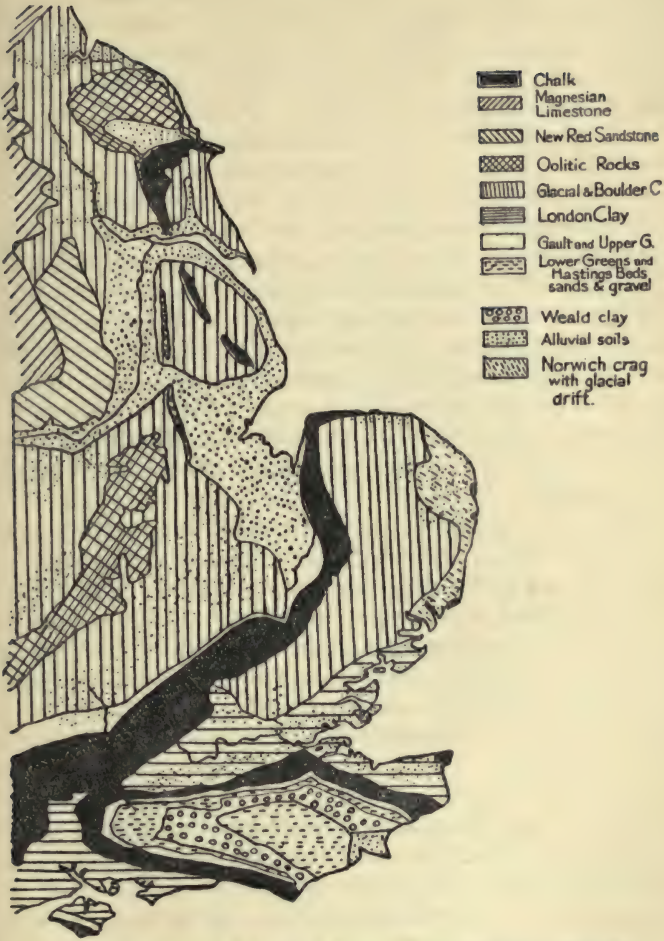

FIG. 63.—Sketch Map of the Surface Soils of Eastern England.

The estuaries of the east coast have always been accessible at high tide to vessels of shallow draught, and thus have formed suitable landing-places for Roman, Saxon, and Danish invaders, and for immigrants from the Netherlands and France —*e.g.* on the Essex rivers occur Colchester (Roman), Romford and Maldon (Saxon), Wakering, Landwick, and Foulness (Danish), and Ostend (Dutch or Flemish).

In time of war this coast has always been unsafe, and the tendency has been for the bulk of the inhabitants to live at some distance inland at bridge towns. The old churches of the coast seem to have been built as small forts as much as places of worship. The danger from invasion has always led to the devising of various means of resisting hostile attacks. The ancient fort-churches, the modern fortified areas near Harwich, Shoeburyness, Tilbury, Grain, and Sheerness, protecting the Thames, the military centres behind the coast at Chelmsford, Colchester, Ipswich, and Norwich, are indications that this coast has no natural defences against invasion from the Continent.

The southern part of the North Sea has always been the fishing and trading ground of East Anglia, and Yarmouth and Lowestoft are still among our most important fishing ports, though Grimsby and Hull, with their better railway services to regions of dense population, have become the chief fishing ports of the kingdom. Harwich, which owes its importance to a band of relatively harder rock along the Stour and to its nearness to the Continent, is a Continental packet station and a naval base. The rich chalk mud of the estuaries, which are dry at low tide, is suitable for the manufacture of cement and bricks, and forms an excellent breeding-ground for the oysters which are "farmed" near Colchester (Essex) and Whitstable (Kent). It should be possible to farm fish in a way similar to that adopted in the fish farms of Arcachon (La Vendée, France) and Carnacchio (Italy).

The mouth of the Thames being the meeting-place of the North Sea and Channel tides, an area of relatively still water

is formed, which gives rise to the deposition of mud at the Thames mouth on a large scale. There being little tidal sweep, the coast-line of Essex and North Kent is in the "senile" stage, the slope of the mud-flats being so gentle that the sea recedes about a mile at low tide. This is the reason why Shoeburyness, with a large stretch of shallow water to the north-north-east, has become the chief gunnery station, shells being fired towards Foulness at high tide and recovered at low water.

The early Saxon invaders were both fishermen and farmers, and the soil being fertile, the climate hot and dry enough in summer to ripen corn and cold enough in winter to assist in breaking up the surface soil, and the period of summer sunshine being greater than elsewhere, numerous small farming villages grew up on the rivers. Improved methods of cultivation discovered on the Continent were established here first of any place in the British Isles. The three-field system was early replaced by the Norfolk four-year rotation of crops, with the result that this region became the most densely populated and civilized part of Britain during the Middle Ages. Popular movements, such as the Peasants' Revolt of 1381, found their chief support in the Eastern Counties. Its natural wealth and culture made Cambridge a university town. By contrasting the relative density of population of the Eastern Counties and the other parts of England before 1750 and at the present day, we get some idea of the wonderful change wrought by the Industrial Revolution.

AGRICULTURE.

Agriculture is the chief industry. The following table has been extracted from a paper on "The Agriculture of the United Kingdom" by Lieutenant Stacey:—

PERCENTAGE AREAS OF LAND IN THE EASTERN COUNTIES UNDER CULTIVATION.

	Arable Area.	Wheat Area.	Barley Area.	Oats Area.	Roots Area.	Cattle per 100 Acres.	Sheep per 100 Acres.	Pigs per 100 Acres.
	%	%	%	%	%			
East Riding .	59.8	8.0	10.5	12.1	12.6	13	58	7
Lincoln . . .	58.6	9.3	12.4	6.9	11.8	14	55	6
Rutland. . .	32.9	3.9	10.9	3.0	5.8	20	82	2
Nottingham .	40.6	6.3	6.4	6.6	7.4	16	32	4
Norfolk . . .	59.5	9.2	14.4	5.8	13.4	10	31	8
Cambridge . .	67.8	18.0	10.2	8.0	11.2	9	24	10
Huntingdon .	52.1	14.2	9.0	3.9	6.3	12	29	8
Suffolk . . .	59.5	11.7	12.6	5.0	8.3	8	31	7
Bedford . .	47.7	12.5	4.2	6.6	5.8	11	23	8
Hertford . .	49.7	14.1	4.6	9.3	5.5	10	18	6
Essex . . .	51.8	13.1	6.3	6.5	5.3	9	19	7
Kent . . .	30.5	4.9	3.1	4.5	4.3	9	89	6

The plains produce oats, wheat (chief area for wheat in the British Isles), barley, beans, potatoes, mangolds, hops (in Essex and Kent), and cattle. The chalk hills are used for the rearing of sheep and horses (*e.g.* racehorses at Newmarket and Epsom). The Oölite districts support large numbers of cattle.

THE RIVER TOWNS.

The Witham flows north from the Northampton uplands, breaches the Lincoln Edge, and continues south-eastwards to the Wash. Grantham, in a gap in the Oölite escarpment, where the river is bridged, commands the entrance to the Trent plain, and has thus become both a market town and a railway centre. Lincoln, on the gap where the Witham breaches the Lincoln Edge, commanded the Roman highroad along the Lincoln heights, and was the focus of the Lincolnshire ports. Prosperous in mediæval times, it remains a market and railway centre, and manufactures machinery and agricultural implements. Horncastle, a Wolds town in the Witham valley, has an agricultural market and horse fair. Boston, at the lowest bridge across the Witham, is a market and port. In

the days when ocean-going shipping of shallow draught could reach it, it was an important port. The silting up of the Wash has made it impossible for large modern vessels to reach the town. During the last few years its oversea trade has revived a little.

The Nen rises in the Northampton uplands, where the pastoral centre, Northampton, has developed leather industries, boots and shoes being made at Northampton, Kettering, Wellingborough, and Daventry. Oakham has a boot-making industry and iron mines. Peterborough, where the Nen enters reclaimed Fen country, is a railway centre, makes bricks, and has large engineering works. Spalding, where the Welland is bridged, a junction on the Great Eastern Railway, is a market town, and was formerly a busy little port. The Wash is of little importance. It has considerable shrimping grounds.

The Ouse valley is extremely fertile, and has developed several industries. The wheat straw of Bedfordshire is suitable for the straw-plaiting industry, and has given the market towns, Luton, Dunstable, Hitchen, and Bletchley, straw hat and paper manufactures. Bedford itself, where the Midland Railway bridges the Ouse, is an educational centre, and makes lace and agricultural implements. Huntingdon, at the bridge where the Great Northern Railway crosses the river, is a market for all agricultural and dairy produce. Cheese (Stilton), other dairy produce, and fruit are marketed, while paper and parchment are made in the district. Ely was formerly an island in the Fens (cf. *Hereward*), and was a suitable centre for the oversight and control of the Fens. It is on the main line of the Great Eastern Railway. Cambridge, on the Great Eastern main line, is an important agricultural centre, and is surrounded by market gardens. Its university specializes in mathematical and scientific studies more than Oxford, which has a bias towards literature. March, a small market town, makes agricultural implements. King's Lynn, formerly an important port, is a railway junction on the Great Eastern Railway. Hunstanton (a watering-place), Bury St. Edmunds

(a market town), and Thetford (a railway junction for the distribution of fish from Yarmouth) are the only other towns in the Ouse basin worth mentioning.

The Wensum-Yare basins have produced two important towns. Norwich, formerly a good harbour, with heights forming a suitable site for a castle, situated among the sheep farms, became an important woollen manufacturing town, and was the focus for trade with the Hanseatic League and Holland (1326, immigration of Flemish weavers, and in 1582 of 5,000 Dutch and Walloon Protestants). A few small industries are carried on—*e.g.* the making of silk (crape), mustard, starch, boots, clothing, and aircraft. The Broads supply its market with large numbers of fowls, and it is still one of the most important towns on the main Great Eastern line. Yarmouth is a seaside resort, and remains an important fishing port. Lowestoft, like Yarmouth, combines the holiday resort and fishing trades.

The Orwell and Stour valleys have occupations similar to those of Norfolk. Stowmarket manufactures explosives, and Sudbury, on the Stour, silk. Ipswich is a large market town at the lowest bridge over the Orwell. It manufactures agricultural implements and has flour mills. Colchester (river Colne) was a Roman station, and later a mediæval bridge town. It is on the main Great Eastern line, and manufactures iron goods. The muddy creeks, which contain fresh water and land waste material, give oyster beds from Colchester to Maldon. Chelmsford (river Chelmer), a bridge town, has remained an important market for agricultural produce. Romford uses the hops of Kent and the barley of Norfolk for brewing. West Ham, which includes the Victoria Docks, makes chemicals, including soap and manures and Great Eastern Railway plant, while Braintree manufactures silk stuffs.

Most of the towns of East Anglia are situated near bridges across rivers, and the biggest towns became important because of their position on main roads. Their growth during the

last century has depended on their nearness to the main railway lines.

QUESTIONS AND EXERCISES.

(1.) Show how the climate and soils of South-east England determine the occupations of the people.

(2.) Give an account of the influence of the eastern fishing industry on the growth of England's mercantile marine and navy.

(3). What industries are the Eastern Counties likely to develop ?

(4.) What do you mean by scarplands ? Where are they situated ? How were they formed ? What are their natural productions ?

(5.) Write a description of the routes by which an invading army landing on the Anglian coast would march on (*a*) Birmingham, (*b*) London. Give your reasons.

(6.) Draw a map of the rivers which drain into the Wash. Insert the chief towns.

REFERENCES.

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Memoirs of the Geological Survey.
Returns of the Board of Agriculture and Fisheries.

CHAPTER X.

THE THAMES VALLEY AND THE SOUTH COAST.

CLIMATE.

CONSTRUCT isothermal and rainfall maps of the area. It is found that the area becomes wetter and less extreme towards the south-west. As a result there is a greater amount of pasture and woodland on the less porous soils, and crops which are easily injured by frost thrive—*e.g.* early vegetables and fruits. There is a much denser growth of deciduous trees than elsewhere in the British Isles.

PHYSICAL FEATURES.

Draw a sketch map from Essex to the Severn, showing the Thames and all its tributaries; the Medway, Stour, Ouse, Arun, Adur, Itchen, Test, Avon (Salisbury), Stour (Dorset), Frome, Axe, Exe, Teign, Dart, Tamar, Torridge, Tawe, Parret, Tone, and Avon (Bristol); the islands—Sheppey, Wight, Lundy, Channel, and Scilly; the hills—Chilterns, Coteswolds, White Horse, Marlborough, Mendips, Dorset, Blackdown, North and South Downs, Hindhead, Leith Hill and Forest Ridge, Salisbury Plain and the Weald, Exmoor, Dartmoor, Bodmin Moor, Blackdown Heights (Devon); the chief headlands; the Solent, Spithead, Goodwin Sands; and the chief places on the French coast—Dunkirk, Gris Nez, Calais, Boulogne,

Etaples, Montreuil, Abbeville, Dieppe, Havre, Rouen, Cherbourg, Brest, St. Malo, and the rivers on which they stand.

Refer to a relief map, and contrast the amount of low-lying land with that of the Eastern Counties. What effect will this have on the length, depth, and speed of the rivers?

Refer to the geological map of the British Isles and to the outline map of the soils of eastern England (Fig. 63, Chap. IX.). What are the rocks of which the hills are composed?

Remembering that chalk is porous, we shall expect a large proportion of the rainfall in the chalk districts to be absorbed, and many of the valleys will only be occupied by streams after heavy rains. Remembering also that the Great Ice Sheet stretched as far south as the Thames, the occurrence of large valleys now occupied by small streams with sheets of sand and gravel may be due to the rapid melting of the ice and snow of the Ice Age, causing the cutting of wide valleys and deep gorges, the sands being left on the hilltops south of the ice sheet as the snows above them melted. On the other hand, the normal stages of river development by river capture by subsequent streams would account for many of the river valleys.

There are three main river basins bounded by chalk hills. (1.) The Thames basin, consisting in the lower parts of London clay, a blue marine clay weathering on exposure to brown, the fossils of which indicate a much warmer climate than that experienced at present, with Thanet Sands on the north coast of Kent, and Bagshot Beds, of sandstone, containing pudding stones or sarsen stones used as boundaries on the north of the North Downs.

(2.) The Weald basin, consisting of Gault and Greensand clays and sands. The Lower Greensand is chiefly clay, with poor sand, and with alternate layers of thin ironstone, giving rise to heaths and commons too poor for cultivation. The Gault and Upper Greensand is a bluish-green calcareous clay, the green colour being due to nodules of glauconite. The Gault and Upper Greensand is easily worn down, though in some

places it has a considerable thickness—*e.g.* 343 feet at Caterham.

(3.) The Hampshire basin, consisting of London clay and alluvium.

The Downs.

As chalk is porous the drainage is largely underground, and pockets, swallow holes, and dimples or hollows caused by dissolution in acid water are found in the chalk. At exceptionally wet times springs issue at unexpected places, and the dry valleys are occupied by streams. The dry valleys must have been formed when the rainfall was much greater, or when the British ice sheet was melting rapidly and overflowing the chalk hills. Certain valleys in the chalk are **U**-shaped, so that it is possible that during the Ice Age the area was covered with snow, in which case erosion would be rapid if the snow melted rapidly and was reinforced by the water from the melting ice sheet farther north. Such valleys would be gorges. Such gaps occur at Aylesbury, St. Albans, Guildford, Reigate, Maidstone-Rochester, Canterbury-Ashford, Lewes, Petersfield, Alton, Basingstoke, Whitchurch, and Dorchester; Goring Gap, and possibly the Straits of Dover, may have been formed in the same way. On the other hand, the valleys in the chalk may be of more ancient date than the Ice Age, and may be explained by normal river development. These empty, or practically empty, valleys have facilitated the construction of roads, railways, and canals, and have determined the direction of routes from the Thames valley to other parts of England.

The Downs are covered with short grasses suitable for sheep pasture, but for little else. They are in great part treeless, except where sand or clay overlies the chalk, and thus they formed a suitable centre for early civilization when the river valleys were occupied by impenetrable marsh and forest. Thus flints were used as tools and weapons by the people of ancient Britain, and the routes along the ridges of the chalk

became the roads by which Roman civilization entered England: *e.g.* Watling Street from the North Foreland to Canterbury and London was laid on the North Downs. The Downs retained their strategic importance, and the gaps through their ridges became castle towns and recently railway junctions. Their economic importance, except as sheep pastures, has continuously decreased because of the insufficient water and timber supplies.

The Downs country of Wiltshire and Berkshire illustrates this. Stonehenge, controlling the Avon, Nadder, Bourne, and Wylye routes from the Avon valley across the Downs, depended to a great extent on dewponds and ponds collecting surface water, was the earliest known centre of population, and was the centre of struggle between the bronze workers of the south-west and the bronze seekers of the east. At a later date the surrounding district became the battle-ground of Bronze and Iron civilizations, Celts and Saxons, Alfred and the Danes. Wilton in the valley, obtaining its water supply from the Wylye, became the capital of Wessex. Old Sarum and Salisbury represent successive steps in the desertion by the population of the Downs for the river valleys as the lower land was drained, and at the present time it is only by careful ponding of the winter rainfall that cattle pastures can be maintained in the little valleys in the Downs: *e.g.* Winterbourne Stoke, a little village near Stonehenge, has an elaborate system of small canals, and sluice gates for watering its meadows in summer time.

The Marlborough Downs show similar features, with prehistoric Avebury abandoned for the Vale of Pewsey and the Kennet valley. The Downs, however, are healthy, and make suitable training places for soldiers and horses—*e.g.* Salisbury Plain; though Aldershot, the chief military centre, is situated on sands and gravels north of the Hog's Back.

The Down villages are generally situated at the junction of the chalk and clay, where water is more plentiful than on the Downs (*cf.* Vale of Pickering in Yorks). Healthy condi-

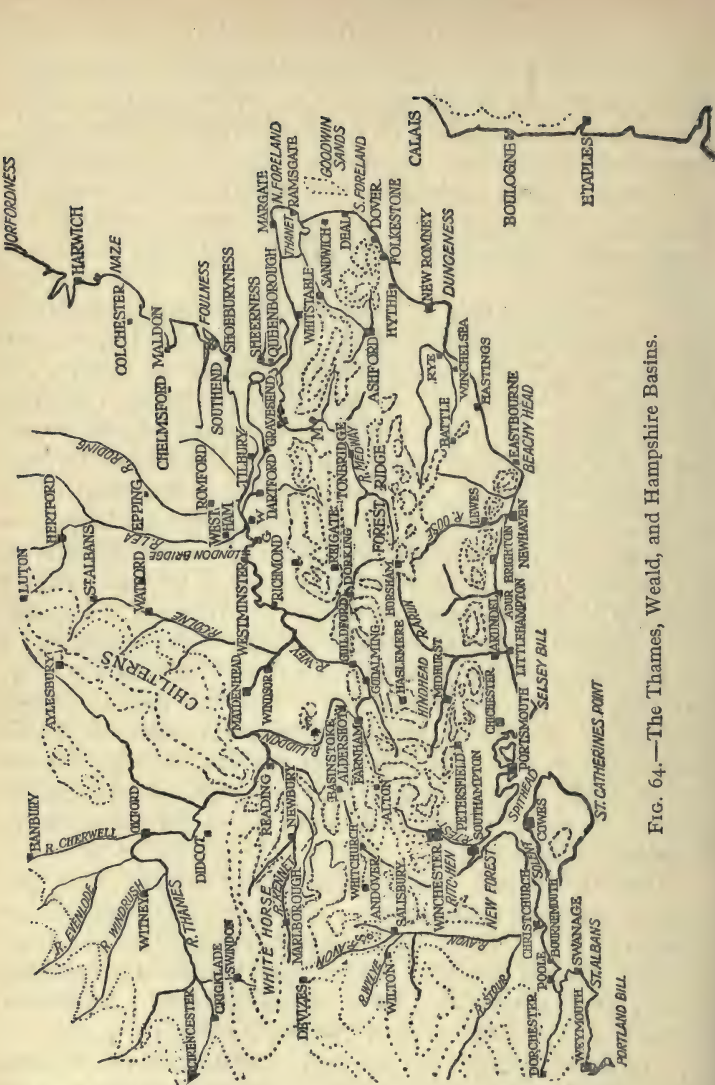

FIG. 64.—The Thames, Weald, and Hampshire Basins.

tions of climate and cheapness have made the Downs near London suitable for the settlement of London's surplus population. Thus people working in London live as far away from the town as Watford, St. Albans, Hatfield, Croydon, Chislehurst, Epsom, Dorking, and Guildford.

The Thames Basin.

The Upper Thames consists of the Coteswold streams, Cherwell, Evenlode, Windrush, Coln, and Thames; and the Thame, flowing south-west from the Chiltern Hills. The Oxford plain was formerly a lake, which has gradually been drained by the Thames deepening its outlet through the Goring Gap. This district was marsh in the time of the Romans, who built roads on the ridges. The area is agricultural, with grain cultivation on the well-drained slopes and with pastures in the damper parts. The sheltered vales of Aylesbury and White Horse are agricultural lands, with a moderate amount of woodland.

The Upper Thames plain is commanded at the junction of the Thames and the Cherwell by Oxford, which was at first merely a safe place in the marshes. Banbury, on the Cherwell Gap across the Edge Hill, commands the route from the Upper Thames to the Midlands and Birmingham. The Marlborough Downs separate the Vale of Pewsey route to the Avon, commanded by Devizes, from the Vale of the White Horse route to the Severn valley, commanded by Swindon, Cricklade, and Cirencester.

The Lower Thames, east of the Goring Gap, commanded by Reading, is a valley in the London clay which occupies the syncline between the North Downs and the Chilterns. Formerly either forest or marsh, it was easily settled by invaders from the sea, so that in course of time the forest was cleared, and little remains except on the lower Chiltern slopes, save from Windsor to Richmond, and Epping Forest (near Brentwood). The river scenery attracts a summer population to Maidenhead,

Richmond, and Henley, while the railway service makes Surbiton an ideal suburb of London. The Upper Lea (*cf.* New River) is responsible for part of London's water supply, though a great deal is obtained from artesian wells sunk through the London clay into the water-bearing chalk.

The Site of London.

A ridge near the present Tower of London where several small streams—*e.g.* the Fleet and Houndsditch—entered the Thames was chosen by the Romans for their fortress. The creeks were used for their ships, and it was near here that London Bridge, which was so low that vessels with masts could not pass beneath it, was built. London Bridge confined the port of London to the east of the bridge, with the result that it is the East End which is the real London, where goods are landed, where trade and industry are carried on, and where foreign immigrants form a large proportion of the total population. The docks, from Poplar to Tilbury, require many men for unloading and warehousing; while the incidental industries in oil, chemicals, paper, furniture, and leather work, in sugar refineries or confectionery works, and the manufacture of silk ribbons, buttons, soap, candles, and the making of clothing, give rise both to healthy factories and to unclean workrooms in dismal tenements. Barges are engaged in carrying cargoes up the river.

Naturally trade and business, as well as industry, became concentrated near London Bridge, and the nearness of the great banks and insurance firms, the Mansion House, Law Courts, Royal Mint, and St. Paul's Cathedral, shows that the centre of London has always been near London Bridge. The royal palace at Westminster attracted Parliament, which was originally a meeting of barons, knights, and men of property; and the "Strand" between London Bridge and Westminster has always been one of the chief thoroughfares of the world. The wealthy people desired to live near the king, and thus

the West End grew up. Learning, of more recent date, was able to house itself in the west of the West End; museums, learned societies, and university colleges being centred in South Kensington.

At last the railways gave London's increasing population the chance of living on the heaths of the moraine soils at Hampstead and Finchley in the north, on the gravels of Blackheath and Bagshot, formerly notorious for highwaymen, in the south-east and south-west, and on the North Downs near Croydon, Chislehurst, Dorking, Reigate (Red Hill), and Guildford, and recently on the gravels of the Weald as far as Farnham. London, for a long time confined to the gravels near it, now stretches from Barking to the tree-clad river terraces near Richmond.

The port of London, east of London Bridge, deals with a tremendous quantity of imports, including tea, coffee, spices, oils, wool, gold, silk, fruits, and meat. Most of these cargoes require warehousing before being broken up and distributed by rail, river, canal, and sea. None of the great railways, except the Great Eastern and the Midland (Tilbury and Southend), have through passenger routes to the docks north of the river; while the South-eastern and Chatham Railway touches Greenwich, Woolwich, and Gravesend on the south: so that much traffic is carried on by means of motor lorries between the docks and the great goods yards of the trunk railways.

East of London Bridge and north of the river lie Stepney, Limehouse, Whitechapel, and the other slum districts behind the docks, which stretch from the Tower to Barking and Tilbury. The south bank includes Southwark, Greenwich, and Woolwich (the munition works of which occupy a very large area of wet clay land). During the war the munitions industry led to the establishment of dozens of munition works as far as Cliffe and Chattenden on the Hoo Peninsula between the Medway and the Thames. Gravesend and Tilbury were the Thames defences in the time of Elizabeth. Tilbury

has become a great dock town, while Gravesend has retained a barge and river trade, having communications by rail and canal with the Medway port of Strood-Rochester-Chatham-Gillingham.

The Thames estuary consists of marshy flats along the coast of Essex and Kent. There are no towns of any size on these clays, neither on the Medway nor on the Thames, though grazing is carried on and supports small villages. Farther inland on both sides of the Thames are ridges which are cultivated and where railway communications are good. Here market-gardening is carried on. Southend, Westcliff, and Leigh were villages which the cheap railway journey to London is rapidly converting into a large suburb of London. Sheerness, on the Isle of Sheppey, commands the north coast of Kent and the mouths of the Thames and Medway. It is accordingly the principal fortress defending the Thames. Shoeburyness, a much less important fort on the north bank, is the chief school of gunnery, so that the defence of the Thames estuary depends very largely on these two places. The estuarine clay of the Shoeburyness district is used in the brickmaking industry, the bricks being carried in barges to London.

Agriculture, Occupations, and Towns of the Thames Valley.

Wheat.—The climate being favourable, the clays of the Thames valley are able to produce excellent wheat wherever the land is cheap—*i.e.* some distance from the suburbs—and where the soil is well drained. Thus paper-making and straw-plaiting are carried on where the Chilterns give a pure water supply—*e.g.* in the Hitchen, Luton, Dunstable, Hertford, St. Albans, and Buckingham districts; while grain is also cultivated round Oxford and Didcot and in Essex.

Market Gardens.—Nearer London, where there are good railway services, market-gardening and dairy farms thrive.

Dairy Produce and Poultry.—The Vale of Aylesbury

consists of greensand, and is a rich grazing country devoted to dairy and poultry farming.

The Vale of the White Horse is fertile, and is the main line of communications to the west (*cf.* Alfred and the Danes near Wantage, the Berkshire and Wiltshire Canal, and the modern railway junctions at Didcot and Swindon, the locomotive works of the Great Western Railway).

The Kennet valley is also a military highroad, while Reading, at its confluence, where the Thames flows through the gap between the Chilterns and the Downs, is the chief town west of London, and converts some of its wheat into biscuits.

Wool.—The Oölite slopes of the Thames headwaters are sheep pastures, and gave rise to the manufacture of woollens —*e.g.* blankets at Witney, though the use of coal has banished the industry. The making of doeskin gloves, which does not depend on the nearness of large quantities of coal, is still carried on at Chipping Norton and Woodstock.

Timber.—The clay of Berkshire is still well wooded, and makes Maidenhead a picturesque summer resort for Londoners. From Maidenhead to London the river banks are pretty, giving fashionable summer river resorts at Henley and Staines, and aristocratic schools and military establishments, such as Eton, Sandhurst, and Camberley near the royal palace at Windsor. On the north of the Thames, the beech trees covering the lower slopes of the Chilterns are used in the chair-making and furniture industries of High Wycombe and Wendover, while the gravels have given rise to suburbs near Watford, the healthy situation of Harrow being suitable for a great public school.

Middlesex, besides having market gardens and brickworks, is mainly a residential area, though at Enfield rifles are made, and engineering industries are carried on at Hammersmith and Chiswick.

Marsh and Heath.—The capture of the headwaters of the Blackwater by the river Wey has left a pass between

Farnham and Aldershot, controlled in the past by Farnham Castle and now by Farnborough-Aldershot, the chief military and aircraft centre in Britain. The fact that the sandy gravels from Aldershot to Woking, including Bagshot Heath and Bisley, are of little economic value has probably been a consideration in the enormous expansion of Aldershot as a military

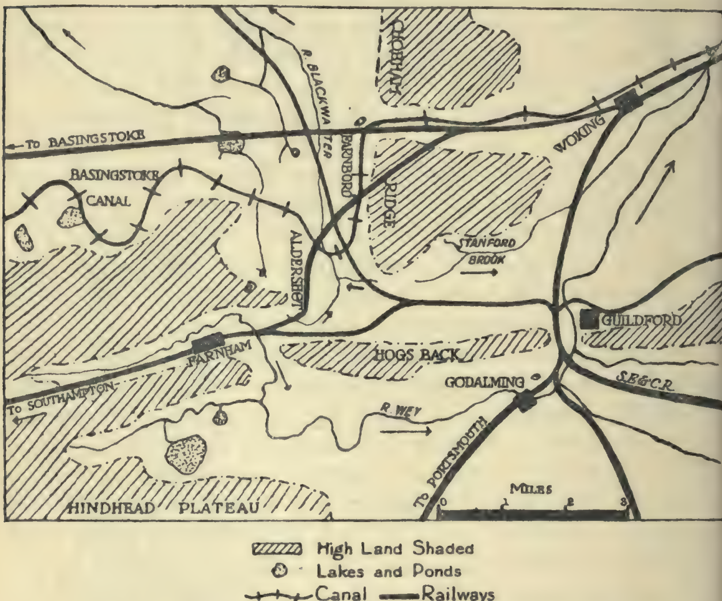

FIG. 65.—Sketch Map of the Aldershot and Guildford Gaps.

centre. At some period in the past a lake probably existed between the Hog's Back (500 feet) and the gravel ridge (Chobham Ridge to Cæsar's Camp) to the north of the Downs. In the course of time the Downs were cut through east of Farnham and at Guildford, and the gravel ridge at Farnborough and near Woking, leaving small lakes at Frensham and Fleet, and marshy vegetation throughout the low-lying

parts of Ashvale and Farnborough districts. The Long Valley at Aldershot is a sandy desert, with empty gullies which contain little or no water in the summer. The formation of these gaps has given to the district of the Hog's Back a control of roads and railways. Woking, the lowest point at the entrance to the Thames valley, commands the main line to the west, to Farnborough, Basingstoke, Salisbury, and the south-west of England, the route through Guildford, and the Southampton route through Farnham, Alton, and Winchester. The South-eastern and Chatham Railway, entering the Guildford Gap from the Weald, is able to give Aldershot direct railway communication with Dover and Folkestone. The lake bed has also facilitated the construction of the Basingstoke Canal.

The Weald.

The Weald (meaning forest) was formerly an anticline, the chalk arch of which has been removed by denudation. The underlying clays were then eroded, exposing long Gault and Upper Greensand clay valleys in Kent and Sussex, leaving the older sandstones, as the Forest Ridge, rising in Hindhead and Leith Hill to nearly 1,000 feet above sea-level. (See diagram.)

The Greensand formation consists of sands and clays. The Upper Greensand is chiefly clay, with some poor sands. The Sandgate beds are alternate layers of sand and clay, known as fuller's earth, which is still dug at Nutfield, near Reigate; the Folkestone beds, with thin ironstone, give rise to heaths and commons too poor for cultivation. The Gault and Lower Greensand are impregnated with nodules of glauconite, which give the calcareous clay a bluish-green appearance. The clay is very easily worn down, and is the most fertile part of the Weald. It is exceedingly stiff and hard to plough, and was formerly covered with marsh and forest (oak). The early cultivators with wooden ploughs shrank from the Weald clay, and as the sands were unfertile the settlements were

small and far apart, and the roads were poor. The Hastings Beds (sand and clay) form the Forest Ridge, and are still heavily wooded.

The Weald forests and marshes formed an almost impassable barrier between the North and South Downs, but as the drainage improved the Weald could be traversed by bodies of horsemen. Thus the Normans attacked London through the Weald, though they found it necessary to establish wooden castles at Folkestone, Hastings, Pevensey, Lewes, Bramber, Arundel, Chichester, Farnham, Guildford, Reigate, Bletchingley, and Tonbridge to maintain their lines of communication.

The introduction of artillery, again, made the forest an

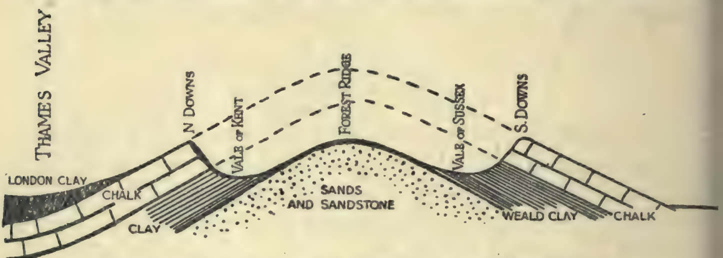

FIG. 66.—Section across the Weald. Dotted lines show former anticline in the chalk.

impenetrable defence line, because the roads were too poor to carry the weight of cannon.

The iron of the Weald has been worked near Battle since the time of the ancient Britons, but not to a great extent till the reign of Henry VIII. From then till the end of the seventeenth century the Weald was the chief iron-making centre in Britain: bars, nails, firebacks, and horseshoes were made for local use, but the manufacture of ordnance began in Elizabeth's reign. Thus we read that the Munitions Controller of Sussex and Surrey—Lord Howard of Effingham—was required to appoint inspectors of the guns produced for the defence of England against the Armada. As a result of the iron industry good roads were made, but the destruction

of the forests by the preparation of charcoal for smelting the iron led to the partial prohibition of smelting, the oak trees being required for the construction of ships and docks for the navy. The iron industry came to an end with the rise of iron manufactures on the northern coalfields, and the year 1811 saw the closing of the last furnace. Evidence of the widespread nature of the Weald iron industry is found in the number of "hammer ponds," where streams were dammed to obtain power for the bellows and for driving big hammers. "Bell pits" and "minepits" are common, particularly where clay, ironstone, and limestone were found together in the forest, which gave an abundant supply of charcoal.

Though the iron industry gradually died out, the need for charcoal in the manufacture of gunpowder increased, and the making of gunpowder became a great industry. (Notice that the Weald is situated midway between the great arsenals of the Tower and Portsmouth.)

Hides could be carried more easily to the oaks than the oaks to the pasture lands, so tanning was carried on and still survives at Redhill. Local sands gave rise to a glass industry at Chiddingford in Surrey, though local petitions were made for its prohibition.

Vegetation of the Weald.

The porous sands, lacking water for roots, are largely covered with heaths, including gorse, which is more sensitive to frost than broom; but where the surface is Chalk there is no heathland, while on the Greensand pines occupy dry places, particularly on the slopes, deciduous trees being found in damp situations—*e.g.* the oak. The ash was cultivated near farms for making hayrakes, flails, sickle hafts, cart shafts, and parts of the wooden plough. The holly grows on both the Chalk and the Greensand, giving rise to place names—*e.g.* Holmwood. The yew is in some places the chief tree on the Downs—*e.g.* Ewhurst; while the larch is found

in places where the Downs are covered with clay. The beech is typical of sheltered valleys in the Chalk, giving in some districts plentiful " pasture " for the swine of Saxon times.

Midway between the Downs in the western part of the Weald the Hindhead-Blackdown plateau of Lower Greensand rises to nearly 1,000 feet above sea-level. It is a region of heavy rainfall, but the porous sands do not allow much water to remain on the surface. The plateau consists of high moors, with pines and deciduous trees on the slopes, contrasting with the well-tilled Low Weald; though many stretches of infertile sand give low heaths. Numerous ravines or coombes, sometimes dry, sometimes containing intermittent streams or bournes, are found on the edges of the plateau; while to the east along the Weald is the Fold Country, of tillage farms which produce oaks, wheat, and grass.

The Lower Greensand hills consist of easily weathered soils, and as a result the lanes of South-west Surrey are generally lower than the surrounding country, deeply rutted by carts in winter and very dusty in summer. The whole of the Weald consists of sand and clay. A mixture of one part of sand with one of clay is called a " loam." If there are two parts of sand to one of clay, the soil is a sandy loam, a clay loam having two parts of clay to one of sand. As a result there are considerable differences in the crops grown, even in the Low Weald. Similarly, the heaths vary—those which grow on peaty soils giving ling (fine-leaved and cross-leaved heaths), the sand gorse, broom, or bracken (*cf.* Farnham—fern-ham). The Scots pine grows both on dry sand and on wet peat. The chestnut thrives on sandy loam but not on clay, and forms a dense undergrowth beneath oaks, particularly on hill slopes facing south.

As a result of the forest growth the timber industry of the Weald is important. During the war large areas of woodland came under the axes of Canadian, Australian, New Zealand, Portuguese, and Danish woodcutters, but this clearing of large areas was exceptional. The chestnut undergrowth is

generally cultivated as coppices, the young trees being cut when ten years old and split into short lengths for palings. At later intervals of fifteen years they are cut into stout poles for hops, while the old wood is utilized by burning for charcoal. The hazel is almost as plentiful in coppices as the chestnut, and in damper ground osiers are cultivated in the same way. Sometimes young oak is seen as coppice growth. Instead of using the quickset hedge of the open country, young trees are partly cut through and bent horizontally, the shoots forming a particularly thick hedge. This is called "pleaching." The forest still supplies timber, hoops for sugar barrels, and charcoal in the Haslemere, Midhurst, and Horsham districts.

Wheat is grown on the lower Chalk slopes, while barley and oats are cultivated on the Greensand, rye being grown to supplement the pasturage for cattle and horses. Turnips and mangolds grow on both Chalk and Greensand soils. Many farms on the heavy Greensand soils have lime kilns for dressing the clay. The Weald and Gault clays were in former times specially important for wheat; but dairy and poultry farming and market-gardening are becoming more important than wheat cultivation. In the past the rearing of sheep on the neighbouring Downs made the district prosperous. (Notice that Guildford retains its annual wool sale.)

Industries and Productions of the River Basins.

The Wey Valley.—The Wey has beheaded the Blackwater, leaving a pass from Aldershot to Farnham, which as a result controls the main route to Southampton. Here there is a little meadow land, but the gravel and loam slopes above the Wey give rise to the cultivation of hops and grain. Farnham is the railway centre for the timber industry of the Hindhead slopes. East of Farnham the Wey turns south, and its well-wooded, fertile but secluded valley was chosen by the Cistercians as the site of their abbey at Waverley. The alluvial belt on the river banks broadens out at Godalming (meadow

of Gudhelm), a district of exceptional fertility, sheltered on all sides by low hills. East of Godalming the Wey turns north to the Thames valley at Guildford, which controls the gap between the Hog's Back and the Downs. Originally a castle town controlling communications between the Weald and the Thames valley, Guildford, on the main London-Portsmouth route, also connects the Aldershot-Farnborough military centre with the ports of the Dover Straits. The early roads of this district followed the high ridge of sandstone and avoided the clay of the Weald. The ironstone of the district was used in the construction of the London-Portsmouth road, and Guildford probably owed its importance to its control of this road. Both Guildford, which is now absorbing some of London's suburban population, and Godalming are market towns.

The Mole Gap.—Dorking and Leatherhead control the Mole Gap through the Downs, and being south of Kingston were formerly important when Kingston was the only bridge west of London Bridge in the coaching days. When railways were constructed, the Reigate Gap to the east offered a slightly shorter route. Because of the railway, Reigate and Redhill are now more important than Dorking. The Reigate stone quarries provided stone for building Westminster Palace and Windsor Castle. The demand for building stone in the London basin led to the construction of the first publicly authorized railway in England here, and the chalk at Dorking is still quarried for lime used in the London building trade. The neighbourhood provided fuller's earth, which was formerly used for cleansing wool and for bleaching calico. The fuller's earth is now chiefly used for dehydrating cotton-seed and other oils, which are then used as adulterants for lard. Bricks have been made for building houses in timber framework since the fifteenth century, while drain pipes and coarse pottery are made at Epsom, Leatherhead, Dorking, and Redhill (red stone hill).

The Medway Basin.—The fertile Vale of Kent contains

magnificent agricultural country, with tillage farms producing grains and cattle foods, meadows feeding fine dairy cattle, and fruit orchards, while the Downs are used as sheep pastures.

Tonbridge is situated at what was the best place between the Forest Ridge and the Ragstone Ridge for crossing the Medway swamps, and was chosen by the Normans as the site of one of their " spade and axe " castles.

The Medway valley produces hops and cherries, besides tomatoes, plums, pears, and strawberries. The Medway pass through the chalk is guarded by a castle town at each end—Maidstone (Medway's Town)—an agricultural market town of the old coaching road type, now a railway junction with a summer river resort trade (*cf.* Guildford); and Rochester, the Norman castle town formerly guarding the Medway mouth, and still commanding the place where the main London road from Canterbury to London (*cf.* Watling Street and Pilgrim's Way) crosses the river. Rochester Bridge acted in the same way as London Bridge, the port of Chatham being situated immediately below Rochester. A military town since Roman times, Rochester was a typically Norman fortress and ecclesiastical town, and the present fortifications of the district, built by the Royal Engineers on the model of Sevastopol, are now used as barracks. Rochester is the residential part of the four Medway towns, Strood, Rochester, Chatham, Gillingham. Strood, opposite Rochester, has enormous chalk quarries and cement works, and manufactures road engines (Invicta). In it lives a large part of the industrial population of the district. (Dickens, who lived at Strood, probably got some of his pictures of fortress, reformatory, and prison life from Chatham.)

Chatham, on the south bank opposite Upnor Castle, near the present munition works at Chattenden and the aircraft station at Hoo, and separated from Rochester by the Brook, a deep valley, commands the concave bends of the river between Rochester and Chatham and between Chatham and Gillingham. It occupied an ideal situation for a naval dockyard in the pre-Dreadnought era, and is still a dockyard for

vessels of light draught (submarines, minelayers, and the like). It is also the headquarters of the Royal Engineers and the Marines. Gillingham, to the east, has piers used in the barge trade of the Medway, while Strood is connected by canal with Gravesend. The Medway below Chatham passes between marshes, and reaches the Thames estuary between the Isle

FIG. 67.—Diagram showing the site of Rochester-Chatham.

of Grain (Port Victoria) and Sheerness, which defend the Thames and Medway.

The Darent is a small stream giving rise to two bridge towns—Sevenoaks, a railway junction, and Dartford, which manufactures chemicals.

The Stour Valley Gap is also commanded by two towns at the ends of its pass through the Downs—Ashford and Canterbury. Ashford, in the centre of the old iron workings, and now controlling the London-Maidstone and the Reading-

Guildford-Reigate routes to Folkestone and Dover, is an agricultural market (hops). Canterbury, which in Roman times was the focus of the ports of the Kentish coast, became the centre from which Southern England was Christianized. As trade with Flanders increased at the expense of that with France, London became more truly the centre of English life; and Canterbury, though still an ecclesiastical and military centre, is at the present day nothing more than a market town on the main South-eastern and Chatham Railway line from London to Thanet and Dover.

Throughout the Vale of Kent fruits and hops are grown, while where railway communications are good market gardening is increasing.

The Forest Ridge and Hindhead.

This area is still densely forested, with timber centres at Horsham and Midhurst. Haslemere, where the Guildford-Portsmouth road and railway cross the plateau, is extremely beautiful, and here an attempt is being made to establish artistic handicrafts—beaten copper work, pottery, cabinet work, embroidery, tapestry, and hand-woven cottons, woollens, and silks.

The Cinque Ports.

The Cinque Ports (Hastings, Sandwich, Dover, Romney, and Hythe, with Rye and Winchelsea) were originally Roman ports, which later became a confederation for defence against Continental invasion. Their fleet was the navy of Saxon and Norman times. They were in their prime in the thirteenth and fourteenth centuries. By 1500, however, they had hopelessly decayed, and were able to muster only thirteen ships against the Armada. Dover alone has remained important throughout. The reasons for their decay are (1) the increase in draught of ships, and (2) the silting up of the harbours by the drift of alluvium and shingle towards the north-east caused by the tide and the prevalent south-west wind. The

Romans began to reclaim Romney marsh, where the Vale of Kent enters the sea. Dover was in a slightly better situation, where a small valley in the chalk cliffs entered the sea (*cf.* Etaples), but only by ceaseless work has it been able to retain its harbour. In the Middle Ages the mayor could summon every householder by drum to take his shovel and help to remove shingle from the harbour. Recently enormous works have been constructed, as the North Sea and the Dover Straits became the centre of British naval power. The drifting of shingle has formed Dungeness, which is in the area where the two tides (high and low) meet, forming an area of relatively still water. Rye has moved as the mouth of the Rother has moved, while Winchelsea, on what was formerly a promontory, has become an inland village. Pevensey, New Romney, Hythe, and Lydd have become inland towns. Folkestone, Dover, and Hastings, on harder and relatively high land, have maintained their importance.

The Stour estuary was formerly tidal to within two miles of Canterbury. Thanet was an island, Sandwich is now inland, the mouth of the Stour having moved north, giving rise to a dune coast (*cf.* Dunkirk district). Off the Sandwich coast lie the Goodwin Sands, sheltering a safe anchorage, except in southerly gales.

During the Great War Dover was the naval centre guarding the Straits; Folkestone the transport town, forwarding troops and materials to Calais, Boulogne, and Etaples; Richborough (Roman) the train ferrying port; Hythe a rifle range; Hastings, New Romney, and Manston (Thanet), R.A.F. centres for the defence of south-east England and London. So, though no longer the sole defence against Continental enemies, the Cinque Ports coast still occupies an important strategic position.

Dover (Calais), Folkestone (Boulogne), and Newhaven (Dieppe) are important packet stations uniting England with France; and though the construction of the Channel Tunnel will make Folkestone and Newhaven less important, they are

at present extremely valuable outports of London. Margate and Ramsgate are healthy seaside resorts, while Hastings, a holiday resort, is only slightly less popular.

The South Downs.

While the Weald coast was defended by Hastings, Pevensey, Rye, and Winchelsea, the western coast of Sussex gave rise to castle towns at the gaps through the South Downs. Lewes commands two routes—the Ouse valley from Newhaven, and the Vale of Sussex route from Pevensey, between the Downs and the forest. Arundel controls the Arun gap, and Bramber the Adur valley. Chichester was formerly the best harbour. This coast has very little economic importance, and is now noted for health resorts sheltered from the north winds by the South Downs—*e.g.* Eastbourne, Worthing, and St. Leonards. Brighton, possessing mineral springs, and the patronage of royalty from the time of the "beaux" to the death of Edward VII., is the chief British seaside resort.

The Hampshire Basin.

Hampshire is a broad alluvial plain, rising in the north and the south into chalk hills, broken in the south by the gaps now occupied by the Solent and Spithead. Like the Weald, the Hampshire plain was formerly occupied by dense forest, of which part of the New Forest still remains. The forest supplied the river harbour of Southampton and the fortress of Portsmouth with timber for docks and wooden ships, and at the present time there are shipyards, especially near Cowes in the Isle of Wight, which build yachts. (During the Great War light naval vessels were constructed instead of yachts.)

The mild climate has given rise to invalid resorts at Bournemouth, Christchurch, Southsea, Ryde, Ventnor, and Shanklin.

Basingstoke, a small market town, and Whitchurch, com-

mand the gap across the North Downs; the South Down passes are controlled by Romsey, Winchester, and Petersfield; while Alton commands the pass connecting the Test and Wey valleys, and shares in the hop production of the Wey alley. The clay region in between produces barley and wheat round Andover. Winchester, commanding the Itchen and Test valleys, is the focus of the Hampshire ports, and therefore of the Continental routes. It was the centre of learning in the time of Alfred, but the loss of Normandy and the decline of French trade made Winchester no longer a suitable capital for England.

The Borders of the Chalk and the Oölite.

(1.) The Western Downs and the Vale of Dorset.

The Northern Downs (Dorset Heights) are crossed by the Stour, Frome, and Yeo valleys, which are pastoral, giving butter and bacon in the Shaftesbury district. Gloves are made at Sherbourne and Yeovil. Dorchester, county town, cathedral, and market, commands the passes over the southern part of the Downs.

The southern ranges give rise to fine coastal scenery, with Portland Bill sheltering Weymouth, which trades with the Channel Islands. The Purbeck Downs at Swanage shelter Poole harbour. Wareham and Swanage have quarries of building stone and Purbeck marble, while between Wareham and Poole clay is sent to the Potteries. The narrowness of Chesil beach has made Portland particularly suitable for a convict station, where Portland stone (Oölite) is quarried. Lyme Regis district has stretches of chalk mud suitable for making Portland cement.

The two fishing ports on this coast are Bridport and Poole, where quantities of mackerel are landed.

Axminster, formerly famous for carpets, has corn mills and brush works.

(2.) The Mendips, Coteswolds, and Bristol Avon.

The Mendips are a continuation of the limestones of South Wales, and exhibit fine limestone scenery (caverns and gorges; *cf.* Cheddar Gorge). From Glastonbury, the outpost of Celtic Christianity, to Wells, their slopes are covered with orchards and dairy farms (Cheddar cheese), but the lead mines are now closed. Weston-super-Mare and Clevedon, at the seaward end of the Mendips, are fashionable watering-places. Frome, at the inland end of the Mendips, near the coal of Radstock, makes broadcloth.

The Avon valley has been partly dealt with under TEXTILES. Devizes, commanding the route from the Bristol Avon to the Salisbury Avon and the Vale of Pewsey, is a picturesque agricultural town (barley market) of the old coach-road type. It manufactures snuff, flour, and beer. Chippenham commands the road between the Bristol Avon and the Thames valley, and shares with Calne (bacon) the prevailing corn, cheese, and broadcloth industries (*cf.* Stroud, Cirencester, Malmesbury, Cricklade, and Swindon). Trowbridge, Stroud, Bradford, and Westbury still manufacture broadcloth.

Bath commands the Avon gap through the Coteswolds, and is the natural market centre of the Upper Avon district. It quarries building stone from the surrounding hills. Its mineral waters have made it a health resort since Roman times, but it reached its greatest importance during the seventeenth and eighteenth centuries, when Bristol was our chief port, sending ships to America and the West Indies, many of the buccaneers having their headquarters there. Bristol, formerly the great American port, has become less important than Liverpool, though its possession of a coalfield and its command of the Great Western Railway route to Cardiff and Fishguard make it one of the most important cities in the kingdom. It manufactures American produce, tobacco, soap, paper, boots and shoes, cocoa and chocolate.

SOUTH-WESTERN PENINSULA.

Construct isothermal and rainfall maps. You will notice that the climate is equable and very damp.

The South-western Peninsula is joined to the Oölite escarpment by a belt of low-lying land composed of New Red Sandstone and other easily weathered soils laid down between Bridgwater and Sidmouth. West of the low-lying land are older sandstones and limestones through which granite and basalt penetrated in past ages. The weathering of the area has given rise to wild but wonderfully picturesque scenery, with deep fertile valleys separated from each other by desolate moors.

Communications between the deep valleys were very difficult before the construction of railways, so that the villages were isolated and had to produce everything they needed. As a result, handwork industries in lace, gloves, and articles of clothing grew up; and though these were ruined by the advent of railways, of recent years there has been a revival because of the quality of the workmanship: *e.g.* Honiton and Tiverton still make beautiful lace.

The Tone and Parret basin was formerly a marsh, and of little use economically; though Taunton, on a hill above the Tone, commanded the fertile parts of the plain before the Bridgwater district was drained. The marsh round Athelney formed a refuge for outlaws in the past (*cf.* Sedgemoor). The scientific drainage of Somerset has converted the marsh into rich pasture land, giving a great industry in butter, cheese, and cream. Peat is still used as fuel, and the peat areas may be capable of commercial development in the future.

Bridgwater, the outlet of the plain, carries on a little shipbuilding. The low tide leaves uncovered a clay sand which is made into bath-bricks.

Exmoor (*cf.* geological map) is a badly-drained, treeless, boggy moor, giving seaside resorts at Ilfracombe and Lynton.

The granite plateau of Dartmoor has been important since prehistoric times as a centre of mineral wealth (tin, copper, granite, and marble), giving rise to towns on the Tamar estuary at Devonport and Plymouth.

The climate and soil of the valleys are suited to the growth of orchards of apples and pears. The Tamar valley between Launceston and Saltash also produces cherries, while the middle valleys of the Tawe and Exe give numerous dairy farms—*e.g.* from Exeter to Tiverton. Crediton has a leather industry. Exeter, a hill-fort bridge town at the mouth of the Exe, is the natural outlet, and has increased in importance since the south-western railways were constructed.

The coast fishermen of Devon and Cornwall were the first Englishmen to venture on the oceans, and the discovery of America and the sea route to the East gave to the western Channel ports a greater importance than that of the Cinque Ports. The ports of the harder rocks of the South-western Peninsula did not silt up as easily as those of the eastern Channel. They were also deeper, and as a result have kept their value with modern vessels of deep draught—*e.g.* Falmouth, Devonport, and Plymouth.

The traffic round the heads of the deep estuaries has given rise to railway junctions like Newton Abbot and Totnes (*cf.* blankets and serges of Ashburton), while the ports of Cornwall are engaged in fishing, quarrying, and mining. Tin is mined at Cambourne, Illogan, St. Just (with copper), and Redruth, while granite is quarried at Penrhyn, and china clay obtained at St. Austell. Truro, at the head of the estuary, is the railway centre. The pilchard and mackerel fisheries of Falmouth, Penzance, Newquay, and St. Ives make these villages attractive to artists, while the climate is suitable for invalids. The Scillies, with a still milder climate, carry on fishing and the cultivation of early vegetables and flowers. The Channel Islands, which are really French, for the same reasons produce early vegetables, fruit, and milch cattle, while their coasts produce shellfish.

Questions and Exercises.

(1.) Write an account of a journey from London to Plymouth by rail. Describe the country passed through.

(2.) Draw a sketch map of the Thames valley and south coast. Insert the chief physical features, towns, and railways. Describe the chief industries.

(3.) Taking the counties of Essex and Somerset, show what different effects situation and physical features have on industrial progress.

(4.) Describe the configuration of the land in the south-east corner of England between the Thames and the English Channel, limiting your answer to the counties of Kent, Surrey, and Sussex. Point out clearly the natural routes from London to (*a*) Dover, (*b*) Hastings, and (*c*) Brighton.

(5.) Draw a sketch map of South-east England to show the North and South Downs and the Weald. Insert the rivers, and mark carefully where they flow through gaps in the Downs.

(6.) Describe the country passed through by one of the main railway routes from London to Plymouth.

(7.) Describe (*a*) the physical features, (*b*) the climate, and (*c*) the soils of Devon and of Lincolnshire. Name the characteristic products and industries of each of these counties, and show how they are determined by the physical features.

(8.) "Early British trade with the Continent produced a series of towns along the southern and south-eastern coasts." Give three examples of such towns. Describe and account for their positions. Say whether they have flourished or decayed in modern times, and account for the facts.

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CHAPTER XI.

THE MIDLANDS.

CLIMATE.

THE climate of the Midland districts is more extreme, while the Welsh mountains cause the rainfall to be scanty except in the hilly districts. Construct a map showing winter and summer temperatures and rainfall.

PHYSICAL FEATURES.

The Lias clay valley north-west of the Oölitic escarpment is practically level, so that the river basins have low watersheds—*e.g.* the Avon and the Welland are only half a mile apart at Bosworth. The Oölite forms a continuous ridge from Lincoln to the Coteswolds, and forms the natural boundary between the Midlands and Eastern England and the Thames valley. Remember the importance of the gaps through the Pennines and the Downs. The gaps through the Oölite gave a political and strategical importance to Tewkesbury, Evesham, Banbury, Edgehill, Warwick, Bosworth, Naseby, and Leicester, paralleled by the control over railway routes exercised by Rugby, Cheltenham, Banbury, Leicester, Melton Mowbray, and Grantham. Most of the other formations are covered by glacial drift, but the moors of the sandstone hills, Cannock Chase, the Lickeys, and Clent Hills are barren, while Charnwood Forest, which includes the granite of Mount Sorrel, Arden, the Forest of Dean, and Sherwood Forest north of

Nottingham, still retains extensive patches of the woodland which, with the marshes of the clay valleys, was the chief vegetation of the Middle Ages.

It is to timber rather than to coal that the Midlands owed their early development. The drainage of the marshes gave rise to the development of agriculture in the clay valleys, while the timber (and charcoal) gave rise to the iron, leather, and pottery industries. The food supply of the forest regions caused the rearing of pigs to be important (*cf.* pork pies of Melton Mowbray, pork of Tamworth, and the chase of the wild boar in mediæval times). Agriculture has declined in importance, and much of the land has been converted into cattle pasture, while the Oölite ridges are excellent grazing grounds for sheep. This change has been accompanied by a drifting of the population into the towns.

West of the Severn are the South Shropshire and Clee Hills, which, with the Wrekin, are composed of more ancient rocks. Glacial drift covers the New Red Sandstone north of the Severn and along the Severn valley, giving rich cattle pastures, while in the Nottingham-Mansfield district the sandstone comes to the surface, giving "soft" water suitable for the washing of textiles. South of the South Shropshire hills, the Wye valley consists of Old Red Sandstone, which weathers into rich soils suitable for cattle pastures and for the cultivation of fruits and hops.

The Midlands are particularly well supplied with widely-distributed coalfields—the Severn coalfield from Wellington to south of Bridgnorth, the South Stafford coalfield from Stourbridge to Cannock Chase, the North Stafford field, embracing the Pottery area, the Nuneaton and Ashby-de-la-Zouch collieries, and the Notts and Derby field north of the Trent. Coal has replaced the use of wood in the metal, pottery, leather, and textile industries of the Midlands, but the number of coalfields has permitted the development of each of these industries near each of the coalfields. Thus the pottery industry is not confined to the Potteries, as salt supplies are found as far

apart as Worcester and Northwich, so that, from Worcester to Derby, all kinds of pottery and porcelain are made. Thus we find Worcester with a china industry, Stourbridge with firebrick, glass, and pottery works, the making of coarse pottery and drain pipes near Dudley continuing in the North Stafford pottery district and extending as far as Derby (china). In fact, the glass and pottery industry extends in patches wherever the New Red Sandstone with its salt and sand supplies occurs near a coalfield (*cf.* St. Helens, Sheffield, and Castleford).

Similarly with the leather industry. The disappearance of the forest (used in tanning) has driven the ancient industry to the nearest coalfield, so that glove-making continues at Worcester, leather is made at Stafford, and boots and shoes in the Leicester and Northampton districts. The weaving of textiles has attached itself to each of the coalfields. The weaving of silk ribbons in the villages near Coventry became the main industry of the town as the coalfield developed, while Birmingham has become a silk manufacturing town, Derby, Ilkeston, Leek, and Congleton retaining their silk industries. Nottingham, Mansfield, and Leicester have become important for the making of hosiery and lace, while Cheadle makes tape and Glossop cotton goods.

It is better, therefore, to regard the industries of the Midlands as having developed from the Middle Ages along natural lines. Such industries as the making of metals, leather, textiles, and pottery have been determined by the pasture and forest producing soils, the numerous small rivers, and the accessibility of salt and pottery materials. The opening of the coalfields has led to the concentration of these industries near the coalfields best suited to their development. Metal industries are general from the brass foundry to the huge furnaces of the Birmingham district, and the ironworks, foundries, and motor and locomotive works of Stafford, Crewe, Derby, Nottingham, Leicester, and Warwick. In the places where these industries do not exist, the Midlands remain a

non-industrial area, with no abnormal increases in density of population.

Areas of Concentration of Population in the Midlands.

The Severn Valley.

The sources of the Severn and the Dee in the Welsh mountains are a matter of Welsh geography, except in so far as they act as reservoirs, Lake Vyrnwy being a reservoir for Liverpool and Lake Bala for Birmingham. Shropshire (Shrub Shire) is mainly pastoral, Shrewsbury (Shrubs-burg) being the chief bridge town of the Upper Severn controlling the railway routes: Great Western Railway—Wolverhampton to Chester and Birkenhead; and the London and North-western Railway, between Crewe and South Wales. Oswestry (Oswald's Tree) is another market town, and is the junction of the Great Western Railway and Cambrian Railway routes to Cardigan Bay. South of the Severn are the Clee Hills (basalt), with an outlying hill, the Wrekin, which exhibits the appearance of a much denuded stump of volcanic rock (*cf.* the Laws of the Cheviots). East of Shrewsbury the Severn enters the Severn coalfield, Wellington manufacturing agricultural implements, Ironbridge, Coalbrookdale, Stourport, Coalport, and Broseley being collieries with hardware industries, Broseley making tiles and tobacco pipes. Bridgnorth and Kidderminster manufacture carpets.

South of the Severn coalfield the river enters the broad alluvial Worcester plain, with Droitwich, a mineral spring resort, producing salt. Hops, apples, pears, and plums are grown, the Pershore district, especially noted for plums, manufacturing cider and perry. Worcester, where a bed of hard rock made a natural ford across the river, on the Roman route to Wales, commanding the Severn, Teme, and Avon valleys, occupies a position of great strategic importance, as is shown by the battlefields of the neighbourhood. It is now a railway and canal iunction. Its agricultural wealth, its salmon fishery,

and the salt of its neighbourhood, assisted its early development. The neighbouring deer forest left behind the industry of glove-making, the Oölite flints a china industry, while its barley fields have given rise to vinegar and Worcester sauce industries.

Below Worcester the valley remains alluvial, the plains of Berkeley and Gloucester producing dairy produce and cheese. Gloucester was formerly the lowest bridge town and the limit of tidal navigation. The building of lock gates below Gloucester prevented Gloucester remaining a river port (*cf.* York). The Coteswold sheep pastures and the suitability of the water of the Frome for dyeing gave a "tweed" industry to Stroud, which commanded the valley through the Coteswolds. Cheltenham's mineral springs and scenery have established it as a health resort.

The Avon valley is mainly a tourist district of literary (Stratford) and historical shrines (Kenilworth and Warwick), while Leamington and Milverton became towns because of the development of their mineral springs. Rugby grew rapidly between 1841 and 1851 when the London and North-Western Railway main line was constructed, and when Arnold was at Rugby. Its modern development dates from 1881, when the alternate bands of Lias limestone and clay suitable for the making of Portland cement at Newbold and Bilton were developed, and since then it owes much to the increase in the importance of the railway, and to the establishment of engineering works between 1897 and 1900—*e.g.* the British Thompson-Houston Company. In this district Watling Street and Fosseway cross. The Fosseway is being made into a main road between Princethorpe and Leicester.

Coventry grew rapidly when the Warwick coalfield was exploited, and became important for the manufacture of silk ribbons, which had previously been woven in the surrounding villages. A coal mine at Bedworth has been worked since 1573, though the modern development of the Nuneaton coalfield has taken place during the last century. About 1870

the manufacture of ribbons declined, and since that time the making of bicycles and motor cars has caused an enormous increase in the population of the town.

The Wye Valley.

The Wye valley was the western boundary of Mercia and Hereford. A river-girt hill guarding the great pass into Wales became the centre of population when the Britons who had clung to the Black Mountain and Malvern moved down to the river. The rich red soil provides pasture for dairy cattle, while the sheltered valley gives rise to climatic conditions suitable for the production of hops and fruits, especially apples. Leominster, commanding the Ley valley, and Ledbury, controlling the route through the Malverns, are small agricultural towns. Quarrying is carried on in the Malverns, while the mineral springs and the wonderful view at Symon's Yat make Malvern a tourist centre, its healthy situation making it a suitable place for a large public school.

The Forest of Dean is more important for its oaks and beeches than for its coal.

The South Stafford Coalfield and the Trent Basin.

The South Stafford coalfield gives rise to an extremely dense population on the elevated sandstone region between the Trent and Severn valleys. Stourbridge has a glass, pottery, and firebrick industry, Redditch manufactures needles, Cradley Heath chains, King's Norton motor cars, Dudley nails and bolts, Wednesbury, Wolverhampton, Tipton, Walsall (locks), and Bromsgrove (bedsteads) make heavy iron goods, Oldbury watches, and West Bromwich small arms, while coarse pottery is made throughout the Birmingham-Wolverhampton area. Birmingham, the second largest town in England, is the centre of manufacture of small metal articles—*e.g.* jewellery, pens, and firearms. It has gradually

absorbed a great many of the surrounding towns, and includes Bourneville (cocoa), Smethwick and Handsworth (machinery, explosives, and soap), and has by its wise municipal government under Chamberlain set an example which London would be wise to follow. It is the seat of a flourishing university, where close attention is paid to scientific industry.

The Lickey Hills, with a slightly heavier rainfall than the rest of the district, are made to supply reservoirs with water for the south of Birmingham. Sutton Coldfield and the north-eastern parts of Birmingham form the residential suburbs.

Lichfield, commanding the junction of the Tame and Trent valleys, was the chief town in Mercia, Offa inducing Pope Aidan to raise it to an archbishopric in 786. It has always been a military centre, though the neighbouring moors at Rugeley were more suitable for the great training camps during the Great War. Uttoxeter and Burton owe their brewing industries to the local supplies of grain, and to their water supplies being particularly useful in brewing. Tamworth, where two Roman roads cross, is the junction of the Midland and London and North-western main lines. Its district is famous for pigs, and there are terra-cotta works there. Leicester, commanding the Soar valley, makes boots and lace and has engineering industries. Derby (Derwentby), the centre of the Midland Railway, commanding the routes east and west of the Southern Pennines to Manchester and Sheffield, has engineering, china, and paper industries. The Peak district, with bracing air and fine limestone scenery, has health resorts at Matlock and Buxton; Bakewell has mined lead since A.D. 300. There are numerous quarries of limestone and marble in the district. Northampton (see EASTERN COUNTIES) is mainly pastoral, and is the chief centre of the leather industry. Nottingham manufactures hosiery and lace, and controls the trade of the Trent valley.

Communications of the Midlands.

There are three main gates to the Midlands—the Midland gate to the Lancashire plain, the Trent valley to the Humber and the Vale of York, and the Severn valleys, leading to South Wales, and through small gaps across the Coteswolds to the Thames basin. The Weaver-Tern gap across the North Staffordshire uplands connects Lancashire with the Severn valley. The Trent and Weaver head-streams make communications easy across the Pottery district between Lancashire and the Trent valley. The Trent valley gives low level communications between the Vale of York and the Tame valley, so that it is possible to cycle from York to Birmingham using a high gear all the way. The head-streams of the Soar and Nen connect the Trent to the valley of the Great Ouse, while the Avon-Cherwell gap gives direct communications between the Midlands and the Thames valley. These low passes have facilitated the construction of canals.

Draw a map showing the canal communications connecting the Midlands with the great ports.

Birmingham is therefore the hinterland of the Mersey, Severn, Humber, and Thames ports, though it depends more on railways than on canals.

Questions and Exercises.

(1.) Draw a sketch map of the Trent basin, naming the hills which bound it. Insert and name (*a*) three of its chief tributaries, (*b*) three of its principal towns. Insert in brackets after the name of each town the chief industry carried on there.

(2.) Describe the position of the Black Country. Between what river systems is it enclosed? Illustrate your answer by a sketch map. Mark on this map the chief towns of the district, and describe and account for its trade.

(3.) "The leading route from London to Ireland through

Wales has changed from time to time. At various periods it has passed through Chester, Gloucester, and Shrewsbury." Trace these various routes through Wales. Give reasons why each of these should have been chosen during any particular period.

Reference.

Wallis, *Central England during the Nineteenth Century: Geographical Review*, 3, 1917.

CHAPTER XII.

WALES AND PARTS OF ENGLAND WEST OF THE SEVERN.

CLIMATE.

EXAMINE winter and summer isotherms and rainfall.

Wales has a mild climate, with a heavy rainfall, particularly on the western slopes of the hills (*cf.* the observations at Tenby, near Pembroke, for the period 1911–13, giving an annual average of 45 inches of rain, a mean maximum temperature of 47° F., a mean minimum of 35° F., a July maximum of 70° F., a July minimum of 57° F., a July mean temperature of 64° F., a January mean of 41° F., and an annual mean of 50° F.). This means that except in the mountains there is practically no frost in West Wales, so that plants which are easily damaged by frost can be grown.

PHYSICAL FEATURES AND NATIONAL TRAITS.

The greater part of Wales is composed of ancient rocks, of which the Old Red Sandstone of the Wye valley forms the most fertile soils. Coalfields extend along the Dee and Severn valleys on the east, and in South Wales the most important coalfield in the British Isles occurs with Liassic rocks on the south and mountain limestone on the north, providing iron ore and limestone for use in the iron furnaces. The hilly parts are blocks of infertile rock covered with moors, and in

some parts quite barren. There is little woodland except on the sides of the valleys. Here and there igneous rocks have been exposed by the general weathering of the Welsh hills.

The hills, with their different kinds of rock, are wild and beautiful, and their beauty and isolation have given to the Welsh their national characteristics—a taste for emotional religion and a narrowness of outlook almost amounting to bigotry. It is not only ancestry that has given to the Welsh their Celtic fire and eloquence. The wild desolation of his barren hills has made the Welshman confident in himself and capable, but mercurial in a degree that makes the Englishman seem stolid. Centuries of fruitless toil on the barren farms has made the young Welshman an opportunist; his traditional literature has promoted a more general desire for knowledge and a higher musical taste than are found in England; and his religious and political fervour have made him successful as missionary and as politician.

Vegetation and Agriculture.

Mountain and heath comprise 28 per cent. of the land, 43 per cent. is permanent pasture, while 15 per cent. is arable. The amount of woodland (4 per cent.) could be very greatly increased, though the area fit for growing crops will always be small because of the high rainfall and poor soils. As would be expected, the low-lying areas and valley regions are the chief places for crops, 4 per cent. of the total area being under oats, 2 per cent. under barley, and less than 1 per cent. under wheat. 1.2 per cent. is under turnips to supplement the sheep pastures.

Wales is, however, important as a sheep-raising country, there being an average of 71 sheep per 100 acres (more than 100 sheep per 100 acres in the more mountainous regions). The valley cattle pastures give an average of over 20 cattle per 100 acres (Anglesey, Pembroke, Carmarthen, and Flint), but the average for the whole of Wales is only 15 per 100 acres

—*e.g.* Merioneth has only 9 cattle to 103 sheep, and Brecon 8 to 104. From this we shall expect the Welsh area to be pastoral country with pastoral industries, except near the Dee, Severn, and South Wales coalfields. The population of the Welsh hills should be small and the fishing industry of Cardigan Bay of little importance because of the remoteness of the fishing villages from centres of dense population. The chief fishing ports should be on the Bristol Channel and near the mouth of the Dee, though the picturesque coast villages should have developed the summer seaside resort industry in degrees varying with their nearness to the large population centres. Thus Bangor, Rhyll, Colwyn Bay, and Llandudno in the north receive a summer population from Lancashire and the north Midlands, Barmouth from the central Midlands via Birmingham and the Great Western and Cambrian Railways, though the more densely peopled coast towns of South Wales, which is an industrial area, do not owe their importance to holiday traffic.

North Wales.

The Dee valley is the most fertile part of North Wales, and produces cattle and dairy produce. Being on the east of the mountains it is dry enough to produce wheat as well as considerable quantities of barley, oats, turnips, and potatoes. Its agricultural wealth has given rise to market towns at Wrexham and Ruabon, which, being near coal, have developed zinc and terra-cotta industries. The Flint coalfield has given rise to chemical works—*e.g.* Cheshire salt, with lead and zinc mines at Holywell, and coal and oilshale industries at Mold. The Clwyd valley commanded by St. Asaph is fertile, with Rhyll, a seaside resort, at its mouth.

The granite and slate of Snowdonia have given rise to a considerable quarrying industry at Bethesda, Llanberis, and Festiniog, with ports at Bangor, Carnarvon, Portmadoc, and Tremadoc. Conway, a castle-bridge town, commanding the route to Anglesey, has a small zinc industry, but owes its

present importance to its scenery. Llandudno is the chief health resort, and owes its importance to its nearness to Lancashire, its accessibility from the Midlands, and to its pleasant climate, its scenery, and to the enterprise of those whose business is to entertain visitors.

Central Wales.

Central Wales is chiefly mountain sheep pasture, with little woollen manufacturing villages which have retained their industries by specialization. Thus Dolgelly manufactures flannel, while the famous sheep pastures and pure waters of the Upper Severn and the nearness of the Severn coalfield have given rise to the making of woollens at Montgomery, Newtown, Welshpool, and Llanidloes. Lead, zinc, and a little gold are mined in the mountains, and the woodlands and mineral springs attract a summer population into the Knighton, Builth, and Brecknock districts. Cardigan Bay has a few fishing towns, of which Aberystwyth, with a university college, is the chief. These towns are places of summer resort.

South Wales.

Of the male population of Wales 46 per cent. lives in Glamorgan and over 60 per cent. in Glamorgan and Monmouth. 3.4 per cent. are engaged in commerce, 10 per cent. in transport, 61 per cent. in industries (*cf.* Radnor 23 per cent, Montgomery 26 per cent., the whole of Wales 54 per cent., England and Wales 47 per cent.), and only 3 per cent. in agriculture (*cf.* Radnor 43 per cent., Montgomery 40 per cent., Wales 10 per cent., England and Wales 8.3 per cent.). South Wales is therefore the most important part of Wales, and is almost purely an industrial region, with the greater part of its population crowded in Glamorgan, West Monmouth, Eastern Cardigan, and South and South-east Brecknock—*i.e.* between lines drawn from Newport to Pontypool and from Kidwelly to Brecknock.

The numbers employed in 1911 in the chief industries were :

	Coal-mining.	Iron and Steel.	Engineering.
Glamorgan	146,000	25,000	15,000
Monmouth	52,000	10,000	6,000
Carmarthen . . .	11,000	7,000	2,000
Brecknock	6,000	200	500

Coal-mining is easily the chief industry in South Wales, and gives rise to great shipping, railway, and metal industries.

(1.) The Coal Industry.

The Coal Measures in South Wales are more disturbed than in any other British coalfield. Faults in the strata make the coal difficult to work, particularly in the anthracite districts. The Welsh coal is dry and fiery, and, owing to the dryness of the mines, the fine coal-dust is a source of danger. The loose jointing of the coal results in many fatal falls of coal from the walls as well as from the roofs of the workings. The quality, however, of the Welsh coal makes **South Wales the chief coalfield of the world.** Its steam coal is unrivalled, while the best bituminous coals, because of their hardness, can stand all sorts of climates, and the Welsh anthracite is quite as good as that of Pennsylvania. All the other British coalfields are fairly level or undulating surfaces, but the valleys of South Wales are extremely deep and narrow. At first this did not matter, as the outcrops on the hillsides were mined and the population was not so dense ; but now the hillside outcrops are almost exhausted, and the pits are situated in the valleys themselves, so that mines, chemical works, and towns are crowded into the valleys. The result is that there is no part of the kingdom where the population is so crowded into deep and narrow valleys as here. As a result, the miners' homes are sunless, without ground for gardens or spaces for open-air recreation—*e.g.* in the Rhondda valley the density of

population in the area built on is 23,000 per square mile. There are three main outlets for the coal. Taff Vale, with Cardiff, carries off the coal of the Rhondda district to the south-east; Newport exports some of the Monmouth coal; while Swansea, Llanelly, and Kidwelly are the ports for the valleys running south-west from the coal area.

(2.) Metal Industries.

It was not until after 1850 that the excellence of smokeless coal made South Wales a great colliery district. Copper-smelting was revived at Neath and extended to Swansea about 1700; and the subsequent establishment of ironworks in Monmouth and North Glamorgan (Dowlais works, 1760), and of tinplate manufactures at Pontypool, gradually extending into Carmarthen, were what originally attracted large numbers of people to South Wales.

The first ironworks were located on the northern fringe of Glamorgan and Monmouth, not with the object of utilizing the coal found there, but because there was an abundance of clay ironstone where the Coal Measures outcropped on the north of the coalfield. Here there was timber, which supplied the charcoal used in smelting, limestone used as a "flux," and furnace sandstone for lining the furnaces.

Thus the iron industry was first attracted to the north of the Coal Measures by the presence of iron ore and wood for smelting. Later, coal was used, and the tinplate industry grew up as a branch of the iron industry. About 1850 the making of steel displaced the manufacture of iron, and the iron industry became increasingly dependent on the tinplate mills. After 1850 steel was used for tinplating instead of iron, and the iron industry dwindled. The discovery in Cumberland and elsewhere of richer ores than South Wales ironstone caused the abandonment of the iron mines of South Wales, and the supplies of iron ore now came from overseas. As a result, the ironworks were moved to the ports (*cf.* Durham)—*e.g.* the Dowlais works were removed to Cardiff.

A little pig iron is still manufactured at Ebbw Vale, Blaenavon, and Merthyr-Tydfil, though these inland towns, with pig iron and Bessemer steel industries, are under a disadvantage with respect to cost of materials as compared with the works on the coast using the Siemens process. Swansea is the centre of a district manufacturing steel rails and tinplate (galvanized iron), three-quarters of the tinplate made in Britain being manufactured near Swansea. In 1911 the number of men employed in the metal trades was :

	Glamorgan.	Monmouth.	Carmarthen.
Iron and Steel . . .	7,000	7,000	1,000
Tinplate	14,000	2,000	5,000
Copper, Brass, Bronze.	1,000	...	500
Zinc	1,000	...	...

Copper-smelting at Swansea dates from the time of Elizabeth. In the modern process acids are needed, and, as a result, chemical works have grown up in the district. Swansea produces 95 per cent. of the zinc (spelter) made in Britain, and specializes in the refining of nickel and the manufacture of copper sulphate and nickel salts (Mond Nickel Co.). Engineering and machine-making, particularly for the railways, are carried on at Cardiff, Barry, Pontypool, Caerphilly, Newport, Neath, and Swansea, while ship repairing has developed at Cardiff, Newport, and Swansea.

Raw materials for the metal industries are obtained from abroad. The tin which was formerly shipped from Cornwall comes from the Straits Settlements, while the palm oil used in the tinplate industry comes chiefly from West Africa. The West African trade has led to the import of rubber in South Wales. Similarly, copper formerly obtained from Cornwall is obtained from Spain, South Africa, and Australia.

Agriculture is carried on in the fertile lowlands of South Wales, particularly in the south coastal plain (Plain of Gwent

and Pembroke), and in the river valleys of Cardigan, Carmarthen, and Monmouth. Mixed farming is general, barley and oats being the chief crops. The raising of cattle is carried on in the lowlands, and sheep-rearing in the more hilly districts.

Pembroke is a naval dockyard commanding the entrance into the Irish Sea. Fishguard commands the Great Western Railway route to Ireland (Rosslare), and is an American trade port. St. Davids, being the focus of the small havens on the west coast route from Ireland, became one of the earliest ecclesiastical centres in Wales, but lost its importance as the prosperity of Glamorgan increased. Llandaff, a bishopric at the old landing-place at Taff mouth, has now been absorbed by Cardiff.

The towns commanding routes into Wales were of vital importance in the Middle Ages, but nowadays, unless they happen to share the industrial importance of South or of North Wales—as at Newport, the Caerleon or western legionary centre of Roman Britain—they are important only as railway towns—*e.g.* Knighton, Builth, and Abergavenny. Fish is landed at Swansea and Cardiff because the fish trade has been attracted to the centres of dense population (*c.f.* the relative importance of Whitby and Hull and of Cardigan and Cardiff).

Questions and Exercises.

(1.) Draw a sketch map of the Severn. Insert the tributaries, chief hills, and chief towns. Give an account of the industries of its valley.

(2.) Draw a sketch map of the Severn estuary, showing the rivers Wye, Parret, Avon, and Usk, with the Mendips and Breckon Beacons. Give an account of the trade of Cardiff and Bristol.

(3.) Describe the river systems of North Wales and of South Wales. Show how the geographical features of Wales have influenced (*a*) its past history, and (*b*) its present population

(4.) Give an account of the distribution of population in Wales. Give reasons for the facts you mention.

(5.) "The borderland of England and Wales is a specially favoured agricultural region." In what respects is it specially favoured? Account for the facts. What are the most important crops produced? Name two of the chief towns in the district.

(6.) Describe the position of the South Wales coalfield. Name three important manufacturing towns in or near it. What special industries has each, and what advantages for them?

(7.) "The same causes which have given Welsh coals their superiority are also responsible for having made mining in South Wales more costly and more dangerous than in the other parts of the United Kingdom." Discuss this statement.

Reference.

Report of Commission of Inquiry into Industrial Unrest, No. 7, Division Wales, 1917.

CHAPTER XIII.

SCOTLAND.

Climate.

Examine isothermal and rainfall maps. You will find that in summer Scotland is colder than England, that in winter the east coast of Scotland is as cold as the eastern counties of England, while the west coast of Scotland is almost as warm as any part of Britain. The isotherms, however, are reduced to sea-level conditions, so that the isothermal maps do not represent the actual conditions of the mountainous parts of Scotland, which are generally somewhat colder than the low-lying parts. Ben Nevis summit, for example, is not much below the level of the snow-line.

The east coast of Scotland resembles that of England in its winter conditions and in its rainfall; and though it is not warm enough in summer for the production of very large quantities of wheat, the length of summer sunlight is a little greater than that of South-east England, and crops of excellent wheat are grown. The chief grain grown is oats, and fruits ripen in sheltered situations. Fruit-farming can be carried on in places where the winter is cold, as mild winters cause the fruit trees to bloom early, in which case the occurrence of late frosts ruins the fruit crop. The frosty winters of the east coast improve the soil for cultivation.

The warmer and wetter west coast is too wet for any crops except oats, hay, and moisture-loving root crops.

AGRICULTURE.

Nearly half (48 per cent.) of Scotland is mountain and heath, and is therefore valueless except for sheep pasture, though afforestation could be carried on successfully on a large scale. While the average area under timber is less than 5 per cent., several districts have considerable tracts of forest—*e.g.* Elgin 15 per cent., Banff 7 per cent., Aberdeen 8 per cent., Clackmannan 10 per cent., Kincardine 11 per cent., and Nairn 13 per cent. The forests occur principally on the valley slopes. There is practically no timber in Shetland, Orkney, Caithness, Sutherland, and Wigtown.

Permanent pastures are found chiefly in the damper parts of the west, where the soil is fertile—*e.g.* Ayr 24 per cent., Berwick 18 per cent., Clackmannan 20 per cent., Dumbarton 16 per cent., Dumfries 17 per cent., Fife 24 per cent., Kinross 25 per cent., Kirkcudbright 17 per cent., Lanark 22 per cent., Linlithgow 31 per cent., Midlothian 19 per cent., Renfrew 34 per cent., Roxburgh 16 per cent., Stirling 21 per cent., and Wigtown 14 per cent.—the average percentage of area for the whole of Scotland being 8 per cent. This accounts in part for the number of cattle raised. Wigtown has 18 cattle per 100 acres, Stirling 11, Renfrew 17, Lanark 13, Linlithgow 16, Kirkcudbright 10, Kinross 13, Fife 16, Dumfries 10, Dumbarton 9, Clackmannan 10, and Ayr 15. The other counties raising considerable numbers of cattle are Aberdeen, 14 per 100 acres, Banff 11, and Orkney 13; but these have more than 5 per cent. of their areas devoted to turnips.

Generally speaking, the counties with the greatest amount of heath in the southern uplands produce the greatest number of sheep. Dumfries has 80 per 100 acres, Kirkcudbright 66, Peebles 90, Roxburgh 125, and Selkirk 106. Berwick, also in the southern uplands, produces 111 per 100 acres, but has a large turnip acreage—9 per cent. Several counties raise sheep on permanent pasture—*e.g.* Ayr with 48 per 100 acres, and Mid-

lothian with 78, while Haddington uses its pasture and raises sheep on turnips as well (74 per 100 acres). Shetland, under great disadvantages, is 98 per cent. heath, and raises 71 sheep per 100 acres.

The average area under wheat in Scotland is .3 per cent. Wheat is chiefly grown in Fife (4 per cent. of total area); Haddington 3 per cent., Linlithgow 3 per cent., Midlothian 3 per cent., and Forfar 2 per cent.

Barley is grown over a greater area in the fertile parts of Banff, Aberdeen, Berwick, Elgin, Fife, Forfar, Haddington (9 per cent. of area—*cf.* whisky and beer of Edinburgh), Kincardine, Nairn, Linlithgow, Midlothian, and Roxburgh.

The crop of oats is five times as big as that of barley, and sixteen times that of wheat. It is grown universally, but is particularly important in Aberdeen (18 per cent. of area), Banff (12 per cent.), Berwick (11 per cent.), Fife (12 per cent.), Haddington (9 per cent.), Kincardine (11 per cent.), Kinross (11 per cent.), Linlithgow (13 per cent.), Orkney (14 per cent.), and Wigtown (10 per cent.).

Root crops, including potatoes, are chiefly grown in Aberdeen, Banff, Berwick, Fife, Haddington, Kincardine, Kinross, Linlithgow, and Midlothian. Fewer pigs are raised in Scotland than in any other part of the British Isles.

Physical Features and Population.

Examine a geological map of Scotland. This will show three main divisions—a region of old or igneous rocks north-west of a line joining Stonehaven with Helensburgh on the Clyde, with a belt of very ancient rocks between Cape Wrath and Skye, sometimes called Archæan, and of which the most noteworthy member is the hard conglomerate called Torridonian Sandstone, after Lake Torridon, where it was first studied. Some people believe that this is a remnant of the lost continent of Atlantis, which was supposed to stretch across what is now the North Atlantic in very remote ages.

If these old and igneous rocks were covered with more recent rocks, it would require a tremendous amount of denudation to reduce them to their present condition. Look now at a relief map of this district, and you will find that the greater part of it consists of high land, the region being fittingly named the Highlands.

(1.) The Highlands.

The Highlands are sharply divided into two parts by Glen More, a trough formed by faulting and deepened by denudation, between Inverness and Fort William. On the east and south-east of this region of old and igneous rocks, and at a lower elevation, is the Old Red Sandstone, which weathers into fertile soils and which is in parts covered with glacial deposits. As a result there is a startling difference between the vegetation carried by the Old Red Sandstone and the other parts of the Highland region. The Old Red Sandstone area is, generally speaking, either grassland or arable land, the valley slopes being wooded. The hilltops of the Highland region generally consist of moorlands, and in places of bare rocks. Such a region cannot provide much food for man except in the valley bottoms, where there is sufficient alluvium for small farms. The west coast folk are therefore compelled to combine fishing and farming (*i.e.* to become crofters), or to become shepherds. The east coast, with its richer soils and fisheries, allows men to be either farmers or fishers. The conditions of the hilly parts resemble those of the tundra, and inland the land is either sheep pasture, grouse moor, or deer forest. Grouse moors and deer forests find occupation for many, but there is no real economy in the spending of large sums of money (*e.g.* on heavy railway fares, petrol, ammunition, house parties); and the employment of large bodies of lackeys, gamekeepers, etc., makes the cost per head of grouse obtained rather high, so that it is only the wealthy who can afford to rent a grouse moor. Even with large areas given over to such an expensive luxury, the population of the Highlands

is small. Large areas away from the coast have less than 1 person per square mile. The river valleys and the west coast have between 1 and 50 persons per square mile, according to the fertility of the soil, while the east coast has from 100 to 250 persons per square mile. The population becomes denser near Aberdeen and between Inverness and Banff.

During the Great War the conversion of the districts round Dornoch and Cromarty and farther north into naval bases gave a temporary increase of population. The effect of soil on vegetation is illustrated by contrasting the Orkneys and Shetlands. The Orkneys consist entirely of Old Red Sandstone overlaid in parts by glacial deposits, while the Shetlands, farther north, consist chiefly of igneous rocks, and have a poorer type of vegetation, though their climate is little colder than that of Orkney. Shetland has 7.8 per cent. of its area arable, 9.2 per cent. permanent pasture, and the rest moor and heath; while Orkney has 38 per cent. arable, 7.1 per cent. permanent pasture, and only 22 per cent. heath. The chief productions, therefore, of Shetland are sheep (76 per 100 acres), cattle (8 per 100 acres), and a little oats. Orkney has 15 sheep per 100 acres, 13 cattle, while 6 per cent. of the land is under turnips and three times as much oats are grown. In neither is there any woodland, peat being used as fuel. Fishing industries are carried on from Kirkwall and Lerwick.

The threat offered by the expansion of the German navy (1904–14) led to the adoption of Scapa Flow (Orkney) as the chief naval station controlling the entrance into the northern North Sea, so that a certain temporary prosperity has set in, but previously these island communities lived under very primitive conditions. Similar conditions of hardship have made the northern Scots the hardiest people in the British Isles.

The sparseness of the population has made the people of the north silent and reserved, and their isolation has given them a narrow Puritanism which has many excellent qualities

that make for reliability, but has about it a rather sombre aloofness from modern life (*e.g.* the giving of a concert in Kirkwall by members of H.M. forces in Orkney during the Great War was made the occasion of a spirited outburst against the moral dangers of such a proceeding).

Fish, wool, and oats are the staple productions on which life depends, the fish being cured for export and the wool made into hand-woven cloth used locally or sent to the English markets—*e.g.* Lewis, Harris, and Skye tweeds. The chief fishing centres are Stornoway, which has been promised new industries by its new owner (Lord Leverhulme), Portree in Skye, Thurso, Wick, and the east coast villages as far as Findon.

Glen More, the lakes of which are linked by the Caledonian Canal, is picturesque, and has a summer tourist traffic which is shared by the railway ports of Oban, Mallaig, and Lochalsh, the outport of Strome Ferry. These towns and Ullapool are the mainland ports for the Hebrides and Skye.

Forts Augustus, William, and Inverness, with Fort George, control the Great Glen, and were used to prevent a united rising in the Highlands. Fort William was built by General Monk and re-erected by William III. as an outpost against the Jacobite Highlanders. In 1715 and in 1745 it was unsuccessfully besieged. At the present day it has a distillery, and uses water-power for the generation of electricity for lighting the town. Fort Augustus was built in 1729 to prevent a recurrence of the 1715 rising. It was captured by the Jacobites just before the battle of Culloden, but recaptured immediately afterwards. Near Fort Augustus the Falls of Foyers are used to generate electricity for the manufacture of aluminium.

The Caledonian Canal was constructed between 1800 and 1822, with the objects of arresting emigration from the Highlands and of giving a safe passage from the Atlantic to the North Sea which avoided the stormy Pentland Firth. Only able to take vessels of 1,000 tons, it was doomed to fail so far

as ocean-going ships were concerned, though it is used for traffic between the Clyde and Inverness and for tourists. Kinlochleven, at the head of Loch Leven, manufactures aluminium. When it is remembered that the climate of the Great Glen is sufficiently mild for the shores of Loch Ness to be covered with such woods as oak and ash, as well as birch and fir, with undergrowth of hazel and holly and similar copse woods, and that the rainfall of the Western Highlands is the highest in Britain, it seems possible that schemes for growing timber on the valley slopes would prove profitable.

The basalt and granite of Islay, Staffa, Mull, Aberdeen, and Buchan Ness can be quarried profitably in those places where there are means of transporting the materials easily to market. Both Aberdeen and Peterhead export a great deal of granite. Other rocks than granite are quarried on the west coast—*e.g.* gray marble near Loch Assynt, and slate at Ballachulish, on the Island of Mull, and near Scarba. The scenery of the Highlands owes much to its slaty and volcanic rocks, the slates giving smooth outlines and the granites weathering into rough crags as in the Lake District.

The Spey Valley runs in a generally north-easterly direction between the Monadhliath Mountains and the Cairngorms, finally entering Moray Firth. Though wide, it is useless for navigation. Of its tributaries the Truim, commanded by Kingussie, runs from the Pass of Drummochter-Dalwhinnie, on the other side of which the river Garry runs down to the Tummel, providing a route through the Highlands for the railway from Perth to Inverness via the valleys of the Tay, Tummel, Garry, Drummochter Pass, Truim, and Spey.

From Inverness to Aberdeen the coast lands produce increasing quantities of oats and large numbers of cattle, though Inverness district chiefly produces sheep (about 18 per 100 acres, which is the average for the whole of Scotland).

Aberdeen, at the mouths of the Dee and Don, uses the Dee as its port, the Don being silted up at the mouth. It is the largest town in the Highlands, with fishing, granite, and

cattle industries, including the manufacture of horn articles. It is the most northern of the jute manufacturing towns, and makes carpets. Situated at the mouths and confluence of the Dee and Don, it commands both valleys and the east coast route to the north, and became important during the Middle Ages. Because of its situation it has become an important railway town in modern times. It possesses a thriving university.

Land communications were not easy in mediæval times, so that the Scottish ports had better communications with the mouths of the Rhine and Seine, and thus with Paris and Germany, than with most places in England. It is not remarkable, therefore, that the Renaissance and the Reformation were brought to Scotland direct and not through England. As a result, Protestantism from Zurich influenced the east coast of Scotland quite as quickly as it penetrated Eastern England through Norwich and Canterbury.

The New Learning likewise was not confined to one or two inland towns, as in England, but was widespread, and gave to Scotland a more general desire for education than was possessed by the English. Aberdeen, St. Andrews, and Edinburgh Universities maintain a very high standard of university training in divinity, medicine, education, science, engineering, and agriculture, as well as in classics and modern languages.

Aberdeen, St. Andrews, Edinburgh, and later Glasgow, seized the chance that English towns with similar communications with the Continent might have obtained. York, Lincoln, Norwich, and London were all mediæval ports trading with the Continent, but none of them established a university, though they were infinitely wealthier than Aberdeen and St. Andrews. Consequently, university life was impossible for any large proportion of the people of England, and to the ancient universities of Oxford and Cambridge was left the sole training of clergy, doctors, scientists, diplomats, and statesmen.

The Tay Basin's head-streams rise in the beautiful corries of the Highlands, and the tributaries give rise to some of the

most beautiful river scenery in the British Isles. There are no large towns on the upper Tay because of the poverty of the soil, but the deep valleys determine the directions of the lines of communication. Blair Atholl commands the exit of Glen Garry, and is linked by rail with Kingussie in Strath Spey. Dunkeld commands the Tay valley at its entry into the fertile Strathmore (Old Red Sandstone), while Perth commands the pass where the Tay breaches the Sidlaw Hills and enters the Firth of Tay. Its water, derived from sandstone, is particularly suitable for use in dyeing (*cf.* Dumbarton). Perth commands the gate of the Highlands, where all the Tay routes converge. This made it a natural capital in former times (*cf.* Scone), and an important railway junction at the present day. The fertile Strathmore supplies its market with oats and cattle, and the hill pastures make it an important centre for sheep.

(2.) The Southern Uplands.

The Southern Uplands is a second region clearly marked on the geological map between Dunbar and Girvan. Composed of old and igneous rocks, we should expect it to be barren, though, as it is not so mountainous as the Highlands, a greater area is cultivated. In the Sanquhar-Cumnock district some of the overlying mountain limestone remains, with the result that, as in the Pennines, lead-mining is carried on at Wanlockhead. The Southern Uplands are the chief sheep pastures in Scotland, and supply part of the wool needed in the woollen mills of the river valleys.

The Scottish woollen industry (tweed) originated because of the pure water for cleansing the wool and because of the abundant sheep pastures in the district. The industry became more important with the introduction of machinery driven by water-power, and, though there is no coal in the district, it has held its own because of the inherited skill of the workers and because it has good railway communications with the coalfields.

The woollen manufacturing towns, like those of the West Riding, are situated at places commanding tributaries of the main valley. Peebles, Galashiels, Selkirk, Jedburgh, Kelso, Coldstream, Greenlaw, and Berwick are all where tributaries enter the main stream, though Hawick, on the Teviot, owes its importance to its superior water-power. Langholm, on the Esk, has a similar position, though Dumfries, which makes tweeds and hosiery, does not owe its importance to its water-power.

There is a larger proportion of low-lying ground in the Southern Uplands than in the Highlands. As a result, there is a great deal more agriculture (mixed farming) carried on. The climate of the south coast is mild and moist, so oats are grown and cattle are reared. Wigtown, with its large area of low-lying land, is the greatest cattle and pig producing county in proportion to its size, while Dumfries and Kirkcudbright, with a greater proportion of moorland, produces twice as many sheep, besides growing considerable quantities of oats and raising cattle.

The natural centres for the disposal of the local produce are the bridge towns at the heads of the estuaries—Wigtown Newton Stewart, Kirkcudbright, and Dumfries. Dumfries occupies the most important position, commanding the south and west coast routes into Scotland and the passes between Nithsdale and Ayrdale, and between Annandale and Clydesdale. Previous to the complete union of Scotland and England, Dumfries was an important border fortress. Stranraer and Portpatrick are connected by steamers with Larne and Donaghadee. Though short, this passage is frequently stormy.

The east coastal plain in the Southern Uplands region is much smaller than that on the south coast. The climate is drier and more extreme, with the result that a greater number of cereal crops are grown, particularly oats, barley, and wheat. More potatoes are grown than in the south, and cattle depend to a greater extent on turnips. Very large

numbers of sheep are reared on the Lammermuirs, and dairy-farming is carried on, though to a less extent than in the south.

The Tweed bridges are the natural markets. Greenlaw, where the Blackadder enters the Tweed plain, is a natural sheep market, while Duns, on the Tweed valley railway, is a market for general agricultural produce. Haddington, a bridge town in the Tyne valley, is the market for the district immediately north of the Lammermuirs. The east coast has a number of small fishing ports, of which Dunbar, once an important cattle town, Eyemouth, and Berwick, are the chief. Prestonpans still produces salt for use in the chemical works of the coalfields, as well as for the curing of fish for export.

Frontiers are generally fortified. Thus the Border country is particularly rich in ruined castles. Berwick, the Border town, changed hands several times, and the whole of the Border was defended by castles—*cf.* Dunbar and Alnwick, Hexham and Jedburgh, Dumfries and Carlisle. The Tweed, like the Tyne valley, owed its industries to its monasteries rather than to its feudal barons, and numerous ruined monasteries attest to the civilizing influence of the Church in the past. The picturesque moors and the ancient associations have attracted the attention of painters and poets (Burns, Scott, etc.) to the Scottish Uplands as much as to the more rugged and barren Highlands. The trout and salmon of the Tweed, and the golf links as well as the literary and historical associations, attract a summer population to the Tweed and east coast towns. In spite of this the population of the whole area is scanty, though considerably greater than that of the Highlands.

(3.) Central Scotland.

The third region is the most important part of Scotland, because it contains the greatest proportion of lowland and because it has important coalfields. The Coal Measures were

laid down at a later date than the rocks of the Highlands, and appear to have been preserved by faulting. The central part of Scotland is a rift valley, with faults dividing it from the Highlands in the north and from the Uplands in the south. As in most regions where great folding and faulting have taken place, there is evidence of volcanic action throughout Scotland in the horizontal sheets (sills) and vertical walls (dykes) of lava (basalt), and in the rounded hills of granite which originally formed in the necks of volcanoes, the softer volcanic materials of which have been removed by denudation.

The glaciation of Scotland during the Ice Age shows the same features as in England and Wales. Steep-sided corries high on the mountain slopes mark the places where the retreating glaciers finally disappeared. Moraine-dammed lakes and the sites of glacier lakes—*e.g.* Glen Roy—passes, corroms (Galloway) where tributaries set free by the melting of the glaciers occupying the main valleys have had to choose whether to follow the original direction of the main streams or flow in the opposite direction, streams joining the main valleys in directions contrary to the present direction of the main streams now occupying the valleys, wide valleys occupied by streams much too small to have excavated them, boggy patches and marshes which were formerly glacier or moraine lakes, narrow gorges, and deep deposits of glacial material covering the east coast and derived from the north of Scotland or from the bed of the North Sea, all indicate that glaciation and subsequent river erosion have had an enormous influence on the present scenery of Scotland.

The formation of the Rift Valley prevented the removal of the Coal Measures by denudation, though all traces of coal have disappeared from the rest of Scotland. Glaciation has occurred all over Scotland, so that Central Scotland bears great amounts of glacial debris and many large erratics. As on the east coasts of England, the drift has had an important effect on agriculture, so that Central Scotland has many

fertile parts even where the underlying rock does not form particularly fertile soils.

The east coast districts of Central Scotland produce considerable wheat crops and large crops of barley, oats, potatoes, and turnips. With only a relatively small amount of pasture, good farmers using turnips are able to keep considerable numbers of cattle. The sheep are chiefly found on the hill pastures in this district.

In all isolated communities all the commodities needed must be produced locally, so that the growing of flax and the making of linen were household arts throughout the Middle Ages in the east coast towns of Central Scotland, with the result that the people had an inherited skill in the making of fabrics, ropes, and sailcloths from fibres. Thus sail-making and the linen industry were carried on near the fishing and whaling ports on the coast. Montrose, Arbroath, and Forfar make coarse fabrics and sailcloth, while Alloa, Dunfermline, and Kirkcaldy, being nearer the coalfields, make finer linens. Kirkcaldy specializes in linoleum and oilcloths.

The imported supplies of oil-seeds and fibre were, as a rule, obtained from Russia, but the Crimean War cut off a large proportion of the supplies. A Dundee manufacturer introduced jute from India, with the result that Dundee became the chief jute-manufacturing town, and has been able to hold its own in spite of the increasing manufacture of jute near Calcutta. Dundee retains its fishing trade, and its position at the Tay Bridge has made it the centre for the trade of the east coast north of Fife, with engineering industries carried on with coal imported from Fife.

The climate, soil, and sheltered position of the Carse of Gowrie are suitable for the growing of fruits and small berries, so that jam manufacture is carried on at Dundee. The manufacture of marmalade attached itself to that of jam, giving trade between Dundee and Spanish and Mediterranean ports. Whaling, of which Dundee was the Scottish headquarters (*cf.* Hull in England), has disappeared.

The Ochil and Sidlaw Hills and the Campsie Fells provide pasture for large numbers of sheep, and woollens are manufactured in Stirling district (*e.g.* at Alva), where raw wool and coal are both available (dyeworks at Perth). Falkirk, which controls the eastern end of the depression joining the Forth and Clyde, has a cattle market.

Whereas the upper Forth is a Highland river famous for its river scenery (*cf.* the Trossachs), and for angling but not for industries, the Forth estuary is an industrial region depending on its coal supplies for the manufacture of iron at Alloa and Falkirk, linen at Kirkcaldy and Dunfermline, for the distillation of oils from oil-shale at Broxburn, Bathgate, and West Calder, for the industries of Edinburgh, the making of explosives at Roslin, near the Dalkeith coalfield, and for coal exporting from Kirkcaldy. The Fife peninsula is an agricultural (wheat, barley, oats, roots, cattle, and sheep) as well as a mining region, with a market at Cupar, the county town, numerous fishing ports, little health resorts, and the university town of St. Andrews on the coast.

Edinburgh.—Just as Perth commanded the gap between the Sidlaws and the Ochils, and Stirling the Forth valley between the Ochils and the Campsie Fells, so Edinburgh became important because its rocks commanded the narrowest part of the coastal strip between the Pentland Hills and the sea. Its fortress, on a hill, was a place of safety during the Middle Ages, and its port—Leith—was on a sheltered estuary. At the junction of upland, lowland, and sea it became a market for the exchange of products. The east coast route gradually increased in importance as roads improved between England and Scotland, and Edinburgh's oversea communications with Scandinavia, the Low Countries, and France were no longer vital to Scotland's existence.

The presence of coal and iron, and the good communications overseas, gave to Edinburgh an era of commercial prosperity just as its strategic importance was declining. The importing of wood, for pit props and for the paper industry, for which

the water of the Pentlands is as suitable as for the breweries and distilleries; a return trade to Scandinavia in foodstuffs and clothing; an increasing fishing industry as the population of the coalfields increased; railway communications with Glasgow, the west coast of England, and with London; and the construction of the Forth Bridge and the naval base at Rosyth, have made Edinburgh, Leith, and the neighbouring places a district of first-class commercial importance.

Chosen as a capital by the Scots because it was the most easily defended place on the main route from England to Scotland, it was not an ideal capital, and for many centuries failed to unite Highlanders and Lowlanders. Scotland did not really become a united nation until Glasgow gave the country a united interest.

Glasgow.—Why did Glasgow become a bigger town than Edinburgh? Edinburgh's hill was the best situation from which to defend Scotland, but it was not on the coast, where its commercial development could more easily have taken place. Glasgow developed when Scotland no longer needed defending against England, and was able to develop freely along the banks of the Clyde estuary. **Glasgow, at the junction of Highlands, Uplands, and Central Scotland, forms the common centre of each. The Atlantic offered more trade than the North Sea.** Glasgow's ford controlled the west coast route, though this was of less importance than that of the east coast until the growth of American trade gave it a reason for converting its river into a deep channel which could be navigated by ocean-going ships.

The mineral wealth of the Clyde was greater than that of the Edinburgh district. Its coal and iron field was the most extensive in Scotland, and here the need for machinery led to the construction of engines driven by steam generated by coal. Steam-power applied to ships and the subsequent construction of iron vessels gave to Glasgow its long lead in shipbuilding, engineering, and other iron and steel trades. Its search for overseas supplies of iron ore, when the blackband

ironstone of the Clyde basin began to be inadequate, led to the importation of iron ores from Spain. Copper ores being obtained from the same place, copper-smelting was established. The need for acids led to the manufacture of chemicals.

The climate of the Clyde valley is damper than that of Edinburgh. It is thus more suitable for textile industries, wool, leather, cotton, and silk goods being made from raw materials. The west of the Rift Valley was not densely populated in the Middle Ages because of the insufficiency of food crops, and the development of Glasgow was impossible until the opening up of America gave to the Clyde valley the opportunity of feeding a dense population. At the present day Glasgow has a very great trade in American foodstuffs, fruits, and tobacco.

The Clyde and Ayr Coalfields.

Mountain Limestone and Coal Measure pastures are suitable for the raising of horses and cattle, while the hilly parts (basalt) are good for sheep. The mild moist climate allows quantities of oats and early potatoes to be grown for the markets at Kilmarnock and Ayr. Dairy produce, butter, cheese, and pork, as well as vegetables, are produced in the Clyde valley below Lanark, and in Ayr and Renfrew.

Coal is mined from Cumnock to Dalry, and exported from Ardrossan, Ayr, and Troon to Ulster, though some of it is used for smelting local iron ore at Dalry and Kilwinning, in the engineering shops and woollen mills of Kilmarnock, and in the lace works of Galston.

The Clyde valley is the chief centre of the iron industry, using an increasingly large proportion of imported ores as the local supplies are being used up. Coatbridge, Airdrie, Motherwell, Wishaw, and Kirkintilloch are the chief iron centres, with copper, coke, oven, and chemical industries. Coatbridge and Airdrie are also engaged in the oil-shale industry—*cf.* Bathgate and West Calder. Glasgow and the towns of the

Clyde estuary are engaged in shipbuilding. Clydebank combines shipbuilding, general engineering, and the making of Singer sewing machines. It is also the centre of the Glasgow sewage purification works.

Dumbarton having refused the honour because "the influx of mariners would raise the price of butter and eggs to the townsmen," a port was laid out in 1688 at Port-Glasgow, because the river was so shallow at Glasgow itself. It was here that the first steam vessel, the *Comet*, was launched in 1811, and shipbuilding remains the chief industry. The Clyde towns were in the West Indian trade from the first, the Darien expedition being fitted out at Greenock as early as 1697. Greenock retains a sugar-refining industry as well as shipbuilding and marine engineering.

Loch Lomond, at one time an arm of the sea, enters the Clyde at Dumbarton (a Roman fortress, later the capital of Strathclyde, captured by the Vikings in 780, and becoming the headquarters of Robert the Bruce's navy), which combines shipbuilding with the Leven calico and turkey red dye trade. Lanark, Hamilton, and Renfrew manufacture cotton stuffs, Paisley thread, while Larkhall has bleaching works. In the neighbourhood of such a dense population summer holiday resorts have sprung up at Dunoon, Rothesay, Lamlash, and Ardrishaig on the Crinan Canal. Campbeltown, in the south of Cantyre, has a small colliery and a whisky distillery.

Questions and Exercises.

(1.) Compare the population of the counties of Argyll, Caithness, and Norfolk, with regard to race, language, and occupations. Add short historical or geographical notes accounting for the facts.

(2.) Draw a sketch map showing the North Channel between Scotland and Ireland. Show Belfast Lough, Strangford Lough, Loch Ryan, and the Kintyre Peninsula. Mark Larne, Ayr, Campbeltown, Stranraer, and Belfast.

(3.) It has been proposed to construct a ship canal connecting the Firth of Forth with the Firth of Clyde, making use of Loch Lomond. Trace the course of the river Forth on a sketch map, showing the Firths of Forth and Clyde and Loch Lomond. Mark Loch Long, the island of Arran, Leith, Grangemouth, Glasgow, Rosyth, Greenock, Alexandria, and the Forth Bridge. Show the probable course of the canal.

(4.) Draw a sketch map showing the position and main features of the topography of the Southern Uplands of Scotland. Show the principal rivers and lines of communication, and mark the chief towns.

(5.) Compare the general distribution of population in Scotland and Ireland. Account for the differences you point out.

(6.) Draw a sketch map of the Firths of Forth and Tay showing the Ochil Hills, the Pentlands, Lammermuirs, Sidlaws, Strathmore, and the town of Stirling. Give an account of the trade of Leith and Dundee.

(7.) Write a short account of the Caledonian Canal, and compare its importance with that of the suggested ship canal connecting the Forth with the Clyde.

(8.) Contrast the Highlands with the Central Region of Scotland. Consider both the physical conditions and the human activities, and give detailed information.

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CHAPTER XIV.

IRELAND.

Climate, Vegetation, and Animals.

Examine isothermal and rainfall maps of Ireland, and compare the winter and summer temperatures and rainfall with those of Britain. Remember that isotherms are drawn from temperatures reduced to sea-level, so that the mountain regions have a slightly lower temperature than is represented by the isothermal lines. In Ireland the temperature of the plains seldom approaches frost conditions in winter, because of the great tempering influence exerted by the surrounding warm seas and by the large number of streams and bodies of standing water in Ireland itself. North-east Ireland has a more extreme climate than the rest of Ireland, and as a result the people of Ulster are somewhat more energetic than those in the rest of the country. The mountainous parts have a slightly lower temperature and a much greater rainfall than the low-lying parts. As would be expected, the south-west and west coasts are the wettest parts, and the east, near Dublin, is the driest part (less than 30 inches rainfall per annum).

The effect of the climate on vegetation is that it is too wet for wheat but not for oats and barley, though the barley grown is more suitable for distilling than for brewing. Roots, particularly those injured by frost, are easily grown. Timber would thrive in the Irish climate more than in any other part of the British Isles, but the surface is covered with grass.

This is an anomaly, because Ireland is climatically a region of temperate forest. The surface rock is in great part mountain limestone covered in many places with boulder clay, and, as trees are absent, it is not difficult for grass to retain its position as the chief vegetation. Considering that in 1913 nearly 40 million pounds' worth of imported timber was used in the kingdom, there seems to be a need for the afforestation of parts of Ireland. Not only is nearly half of Ireland permanent pasture, but 24 per cent. is arable, with a total area equal to half the arable land in England.

Oats is the chief corn crop, the greater part of Ulster having more than 10 per cent. of its area under oats. About 4 per cent. or 5 per cent. of Leinster is under barley, while Louth is the only important barley district in the north. Potatoes are grown all over, but chiefly in Ulster and Wexford. Flax cultivation is carried on in Ulster.

Cattle-raising is more important in Ireland than elsewhere in the British Isles, the total number of cattle almost equalling those in England, and averaging 24 head per 100 acres. Armagh, Dublin, Kilkenny, Limerick, and Meath are the most important centres. Pigs are everywhere important, averaging 5 per 100 acres, Wexford and Central Ireland being the most important areas. Fewer turnips are grown than in Scotland, and sheep are less important than elsewhere in the kingdom, being chiefly raised in the hilly districts and in the drier parts of the upper Shannon area.

Physical Features.

Examination of the geological map of Ireland shows that the surface rock of Central Ireland is Mountain Limestone, and that, overlying it in several places, are Coal Measures. The other rocks are, as a rule, older or of volcanic origin—*e.g.* (1) the north-eastern plateau consists of basalt which penetrated the chalk which once covered the north-east coast; and (2) the west coasts of Connaught and Ulster, and parts of the

south-east of Ireland, have granites and rocks, the nature of which has been changed either by heat or by pressure, or by a combination of both.

The whole surface of Ireland has been changed by glaciation, and on the low-lying parts are heaps and ridges of moraine material, which hinder drainage, already made difficult by the flatness of the surface. As a result, water standing on the clay tends to become choked with bog. Where the limestone is drained the surface is covered with grass. The scenery of the plain is rather monotonous, though the acid nature of the peaty waters has allowed the streams to dissolve out beautiful lakes in their courses, and their irregular shapes and numerous islands, where the surface of the limestone has been protected by clay or other non-porous material, gives a picturesque effect to the scenery of certain parts. (Lough Derg is surrounded by insoluble rocks, the limestone having been dissolved.) The underground drainage of limestone streams has been noted on the Pennines and the Downs. Ireland has a more continuous stretch of limestone country, with the result that there are numerous caverns, particularly in the regions of the Upper Shannon and the Upper Erne, and in the Galty Mountains, while in the west Lakes Corrib and Mask are joined by an underground stream.

The basalt of the north-east reaches the sea at Fair Head. The coast being chalk from Larne to Fair Head, the coastal scenery is full of contrasts, the famous columns of Giants' Causeway showing the form in which lava (basalt) cools. Volcanic regions are unstable parts of the earth's crust, and faults are frequently found—*e.g.* Lough Neagh was formed by the subsidence of basalt due to faulting, and could not escape into the Irish Sea because of the accumulation of moraine material on the south. There is a great difference between granite and basalt, the granite forming domed summits, the basalt, plateaux with precipitous cliffs. Thus the mountains of Mourne slope down to the sea, giving rise, as in Dundrum Bay, to a landscape with smooth outlines, which contrasts with

the little bays and rock-bound coasts of the Portrush district, the scenery of which has made the little bay villages into summer holiday resorts.

Though the region of igneous rocks is not particularly fertile, the soils derived from them are rich in plant food; so that, as a large part of North-east Ireland is covered with glacial deposits derived in part from igneous rocks, the soils of the valleys of the Bann, Lagan, Blackwater, Fane, and Boyne make this the chief agricultural region in Ireland, and except in the mountain regions the population is dense. Large quantities of flax are still grown, though the tendency is, in peace time, to rely on flax from the Baltic countries.

The south-east of Ireland consists of highlands with a N.E.–S.W. axis, but very much denuded. These highlands are composed of ancient rocks through which granite has forced itself during the volcanic period, with the result that limestones have been changed into marbles. Glaciation has left this district of mixed rocks a very beautiful series of well-timbered valleys—*e.g.* the Vale of Avoca—while in the mountains copper, iron pyrites, and small quantities of gold have been mined.

The south-western highlands are folded ranges with a W.–E. axis (*cf.* South Wales and Brittany), and the rivers flow either east or west. They have, however, abrupt turnings, and enter the sea on the south coast. Whether the main E.–W. streams were once tributaries which have enlarged their smaller tributaries and beheaded the streams to the west, leaving the passes at Mallow, Fermoy, and between the Knockmealdown and Comeragh mountains, is not certain. The beautifully wooded lakes of Killarney are in a glaciated district and are probably of glacial origin, like most of the lakes in the British Isles.

The most ancient rocks known (*cf.* Northern Highlands of Scotland), the Archæan, are found on the north of Galway Bay, covered with bogs and lakes. The mountains of the west consist of old rocks changed by heat or pressure into crys-

talline rocks, which give deep narrow valleys with deep lakes. The excessive rainfall and non-porous rocks make this a region of bog, with the result that though the average population per square mile is very low, the amount of habitable ground is so small that the district has too many inhabitants. This causes a constant stream of emigration to the more fertile east, and makes it necessary to give state help to enable the people of the extreme west to live (*cf.* the work of the Congested Districts Boards). The fisheries here are near the edge of the Continental Shelf, and, though they assist in the feeding of the inhabitants, their remoteness from large centres of population prevents the foundation of a fish industry at all comparable with that of the east coasts of Britain.

Occupations and People.

Ireland is less wealthy in minerals than Britain, and the bulk of the population is engaged in agriculture.

(I.) **Minerals and Fuel.**—Granite is quarried in places where transport is not difficult, particularly in Wicklow, Donegal, and Galway, the Mourne Mountains granite being exported via Newry. The metamorphic rocks formed by the fusing of rocks under high pressures and temperatures include many beautiful marbles. Black marble is obtained from Galway and Kilkenny, red marble at Little Island and Fermoy, gray marble in Donegal and Roscommon, and green marble in Connemara and Galway. Slate is quarried at Carrick, Killaloe, and on Valencia Island. Fine sand, suitable for making dynamite compounds, is found in the Wicklow Hills, Arklow manufacturing cordite. Iron ores are mined in Kilkenny, Tyrone, Leitrim, at Arigna, and in Antrim near Glenarm, Ballymena, and Cushendale, where it is found near limestone (*cf.* the Lias ironstone of England). Bauxite, an aluminium silicate which can be fused at high temperatures, is obtained in Antrim, and sent to Scotland for use in the making of aluminium.

Ireland, like most other countries, has neglected its timber supplies, and the present lack of timber is partly due to the former use of wood in smelting. The northern coalfields produce a bituminous coal, the southern anthracite (*cf.* South Wales). The chief coalfields are Kilkenny (Castlecomer), Tyrone (Dungannon), Antrim (Ballycastle), and Leitrim (Arigna), while the Cork, Kerry, and Clare fields are not worked. Rock salt is found in Antrim.

The large amount of bog land in Ireland gives rise to an abundant supply of peat, and in recent years peat has become an important article of commerce, though for a long time it had been used as the peasants' household fuel. At Kilberry, near Athy (Kildare), what is known as electro-peat coal is made. The peat is pressed to remove water. It is then dried by having an electric current passed through it, broken, pressed into briquettes, and dried. It is claimed that it generates greater heat in a shorter time than steam coal. Hydrocarbon gases, oils, and organic acids (creosote) can be obtained from the distillation of peat, and paper and "wood" blocks for paving can be made from it. The chief use of peat in England is as moss litter, which is used in stables, and absorbs moisture and smell at the same time. It is particularly good for horses suffering from diseases of the feet. After being used in the stable the moss litter is not useless, but can be used as manure.

(2.) **Agriculture.**—Climate and soil make Ireland the chief dairy-produce country of Europe, but the Irish are a long way behind several Continental countries in organizing their dairy industries. Formerly potatoes were the chief crop, but the large areas of well-watered grasslands make Ireland a cattle-producing country, with milk, cheese, and bacon as by-products of the beef-producing industry, and with the manufacture of leather for harness, an industry in all parts of Ireland, tanning being carried on in all the chief towns—*e.g.* Cork, Dublin, Drogheda, Newry, and Belfast.

The drier limestone regions are suitable for the breeding and training of horses. The east and north produce cart horses,

and the south and midlands are noted for hunters and cavalry horses. Sheep are less important than in Britain, though the hills produce sufficient to supply wool fairs at Ballinasloe, Tuam, and Dublin. Flax is chiefly grown in the north-east, where the soils, which are either glacial or derived from igneous rocks, are fertile. The Great War, by cutting off foreign supplies, has caused an increase in the acreage under flax both in England and in Ireland, though the resumption of normal trade with the Baltic will probably cause a decrease in the amount of home-grown flax.

Although the pastoral trades are the most important, a large number are employed in trades dependent on the cultivation of grains. The barley is not suitable for brewing exactly the same kind of beer as is made in England, but brewing is carried on generally, Dublin (porter), Cork, Drogheda, Dundalk, Kilkenny, Waterford, Dungannon, and Clonmel having railway communications, and a sufficient coal supply, or a sufficiently dense local population to create a local demand for quantities of drink, as well as supplies of grain sufficient to supply brewing industries. The national alcoholic beverage, however, is "usquebaugh" or whisky, and Dublin, Belfast, Cork, Birr, Londonderry, Coleraine, Kilbeggan, and Tullamore have distilleries (*cf.* Scotland). The high duties and consequently high prices have made the manufacture of spirit in illicit stills a profitable though illegal trade, which is still carried on to a small extent in remote parts.

(3.) **Fisheries.**—The Continental Shelf is narrow off the west coast, so that the chief fisheries are off the south coast and in the Irish Sea, near the centres of population, where good markets can be found. The south-west and west coasts are noted for mackerel, which is salted and exported to America. The large boats are engaged in deep-sea fishing in the spring, while the autumn sees the smaller boats busy with the near shore fisheries. Cod and ling are found off the south coast and in the Irish Sea in winter and spring, while salmon are caught in the mouth of the Shannon, and in the Corrib, Erne,

Foyle, Bann, and Boyle. Eel-fishing is carried on in the Shannon, Bann, Erne, and Corrib.

(4.) **Shipbuilding** is chiefly carried on at Belfast, though other towns are engaged in turning out smaller vessels—*e.g.* Londonderry (with rope works), Dublin, and Cork.

(5.) **Textiles.**—The majority of the Irish are Roman Catholics, and beautiful hand-made lace is produced in the convents (*cf.* Belgium). Hand-woven Irish tweeds are made in many parts, the dyes being obtained from plants. Sports coatings, carpets for the White Star liners, and poplins are all of Irish manufacture. The standard of workmanship throughout the textile industries is very high. Linen manufacture is chiefly centred in the north-east, particularly at Belfast.

North-eastern Ireland.

The Linen Industry.—North-eastern Ireland, like the chief English textile centres, owes a great deal to foreign immigrants. In very early times Irish linen was known throughout England. In 1685 the Revocation of the Edict of Nantes drove Dutch and French Protestants to the United Kingdom, and a number settled in Ulster and began to improve the native methods of making linen. The introduction of spinning machinery, and improvements in the methods of bleaching, made Ulster the chief linen centre of the British Isles, though the introduction of cotton made it much less important than either the cotton or the woollen districts of Northern England. The American Civil War stopped the cotton mills, and the linen industry thrived.

The linen industry depends on cheap supplies of raw materials, on imported coal, and on a pure water supply for washing and bleaching ; but the chief reason why Ulster has become the chief linen manufacturing centre lies in the energy and intelligence of the mixed population—Scots, Germans, Dutch, French, and native Irish. The cheapness of Russian flax tended to stop the growing of flax in

Ulster, but the cutting off of supplies caused a great increase in the area under cultivation during the Crimean and other wars.

Several towns specialize—Londonderry in shirts, Monàghan and Armagh in brown holland, Portadown and Lurgan in lawn and cambrics, and Lisburn in damasks. Bleaching is carried on at Lurgan and at Enniskillen, which is also a centre of flax cultivation. Ballymena, Ballymoney, Coleraine, Limavady, Dundalk, Donaghadee, and Drogheda are other centres of linen manufacture. Belfast is a particularly suitable centre for linen manufacture. The women work in the mills and the men in the shipyards. This means that there is not much unemployment.

Other Industries.—The coal used in the industries of Northern Ireland is obtained in part from Dungannon and Ballycastle, but the greater part comes from Cumberland and Ayr. Fishing ports exist at Ardglass, Kilkeel, and Donaghadee, but the great proportion of the population, as in the rest of Ireland, is agricultural. The climate is too damp for wheat, but potatoes and oats are grown generally, and the dairy produce, cattle, and horse-raising industry is carried on. Orchards of apples make Portadown a fruit centre. The land is mainly pasture on the rivers Erne and Boyne, with markets at Enniskillen, Mullingar, Longford, and Cavan. The chief ports are Londonderry, Moville (Canadian mails), and Belfast, while Larne, Warrenpoint, and Donaghadee control the routes to Britain. Belfast, the gate to North Ireland, between the Antrim and Mourne Mountains, has four chief industries—linen, ships, whisky, and beer—but is also the commercial centre for the whole of the north of Ireland.

Central Ireland.

Though Central Ireland became a kingdom before the Midlands of England were united, the numerous marshes, bogs, and lakes made it impossible for a strong central power to

grow up under which Ireland could become united. Thus Ireland remained a number of small independent tribes until conquered and given good communications by England. As Ireland was not part of the Roman Empire, it did not lose its civilization when the Roman power was broken. It had become Christian during Roman times, and its isolation enabled it to become a centre of missionary and educational effort while the rest of Europe was reverting to barbarism. Iceland, France, Germany, Italy, and Switzerland were visited by Irish missionaries, to the permanent benefit of those countries. A literature was created when the rest of Europe was hopelessly uncivilized. If Ireland could have developed political as well as religious unity, she might have become a nation, but she was not left in peace. The Danes (Vikings) and Scandinavians attacked the Irish, and seized the estuaries, where they established themselves ; so that at one time it seemed as if they were to obtain control both of the Western Isles of Scotland and of the coasts of Cumberland and Ireland. To this day Dublin has two cathedrals, one of Danish and one of Irish origin.

English invasions under Norman knights followed—from Pembroke to Wexford and the coast of Meath (Dublin to Drogheda), and the east of Ireland was divided into counties. The geographical conditions did not allow the invaders to control the whole of Central Ireland, and, apart from Dublin district (the Pale), Ireland remained independent. Ireland was conquered from the nucleus of English ground at Dublin by improving the methods of communication and by the establishment of blockhouses. The Irish were murdered and driven west of the Shannon and their land given to the Scottish, English, and Dutch soldiers, while large Irish estates were sold to wealthy men who never visited their estates. This system, so obviously unjust, made the Irish anti-English in sentiment, with the result that in spite of attempts to improve the condition of the Irish a large number of the people of Ireland desire to be independent of Britain.

Dublin, with its central position on the east coast at the

entrance to the central plain from England, naturally became the English capital of Ireland. Its commercial importance depends on its being the natural outlet for the produce of the plain, the roads, railways, and canals of which are focused at Dublin. The fact that it faces the densely populated area of Lancashire gives it a large trade in foodstuffs with Liverpool, Fleetwood, Holyhead, and Heysham, and a tourist traffic. Its harbour is poor, but it has a good outport in Kingstown. The local industries for which its water supply is suitable are brewing, dyeing, and distilling; and the skill of its women makes it the chief centre of the manufacture of poplins (a mixture of wool and silk).

The Shannon basin is connected by canal with the north-east and east coasts. It has towns at the bridges, the largest being at Limerick—the limit of ocean navigation—where the cattle of the Shannon valley are collected. The tanning of leather and fishing are its local industries. The northern part of the Shannon valley is not entirely pastoral, oats, potatoes, and dairy produce finding an outlet in Tullamore, while in the drier parts horses and sheep are raised—*e.g.* wool at Ballinasloe. The development of light railways in Ireland will make Mullingar and Tullamore more important.

South and East Ireland.

After the north-east the most densely populated part of Ireland is the south-east. This is because there is less bog. (In Connaught, which has a very small population per square mile, there is overcrowding, each fertile tract being fully occupied, the bog and infertile parts being useless.) Oats and potatoes are the chief crops, and are especially important round Waterford and Wexford, and from Maryborough to Kilkenny. From Kilkenny to Tipperary wheat is grown as well as oats, and horses are raised. Important dairy industries are carried on in the valleys of the Suir (Clonmel and Portlaw), Blackwater (Mallow and Fermoy), and Lee (near Cork).

From Carlow to Kilkenny coal is mined, while iron is raised at Mount Mellick, Kildare. Bagenalstown is a railway centre, which controls traffic in granite, sandstone, and slate, as well as the general trade of the Barrow valley.

The Wicklow Hills are a granite and slate quarrying centre, copper and pyrites being mined in the Vale of Avoca. The river mouth is silted up at Wexford, but Rosslare, the outport, has steamer traffic with Fishguard. Waterford, the gate to the south-east and south-west of Ireland, is also connected with Fishguard. Youghal is the port for the Blackwater, and has a small fishing industry. Cork is the chief port of the south coast. Like many other estuarine harbours, it has developed an outport at Queenstown. It is a centre for the trade in Irish tweeds, and manufactures whisky. Kinsale has a small fishing trade. Berehaven is a naval port.

The North and West of Ireland.

The climate is very damp and mild, being capable of supporting evergreen woods. Unfortunately there are very large tracts of bogland and barren mountains. As in the north-west of Scotland, the pastoral, fishing, and quarrying industries are the chief occupations. Galway, Westport, Ballycastle, Ballina, Sligo, and Donegal are fishing ports. Castlebar, Sligo, and Galway are the chief cattle markets. Marble is quarried at Ballina, Killala, Ballycastle in Mayo, and at Killaloe in Clare.

The greater part of the foreign trade of Ireland crosses the Irish Sea to the Clyde, the Mersey, and the Bristol Channel. Articles of clothing, machinery, and coal are the chief imports. The chief exports are cattle and meat, butter, eggs, bacon, grain, and linens.

Questions and Exercises.

(1.) Compare the general distribution of population in Scotland, England, and Wales. Account for the differences you point out.

(2.) Describe the surface and boundaries of the central plain of Ireland. What are the chief rivers draining it? Give some account of the population and products.

(3.) "The ports on the east coast of Ireland are far more important than those on the west, although the latter possess the better natural harbours." Account for this, and name two ports on each coast which illustrate your explanation. Describe their positions, and give an account of their trade.

(4.) Explain fully why Irish time is 25 minutes slower than English time.

(5.) Draw a sketch map of the coast from County Down to County Donegal. Name the chief headlands and inlets. Insert Giant's Causeway, Larne, Moville, Londonderry, and the mouths of the rivers Foyle and Bann.

(6.) What interchange of productions takes place between (*a*) England and Ireland, (*b*) Scotland and Ireland, and (*c*) England and Scotland? Give reasons for your answer, stating the particular localities from which the articles you mention come.

Reference.

O. J. R. Howarth, *Ireland.* Clarendon Press, Oxford.

CHAPTER XV.

THE DEVELOPMENT OF COMMUNICATIONS IN BRITAIN.

(I.) ROADS.

IT must be remembered that the physical features of the British Isles have altered considerably during historical times, that the changes in the methods of transport have been continuous, and that new inventions facilitating intercommunication are constantly being evolved.

At first, when man travelled from place to place on foot, the physical features determined the lines of communication and settlement. The plains and valleys of the British Isles were occupied by marsh and forest. Thus the movements of men were confined to the more open ridges of the scarplands, and to the less densely wooded valleys and lake edges where they could get from place to place in their flimsy boats. The remains of pile dwellings have been discovered in many places formerly occupied by lakes (*cf.* Lake Pickering), and coracles are still used by fishermen on some of the Welsh rivers.

The Romans owed the permanence of their power to the roads they made. (Construct on transparent paper a map of England to the same scale as the physical features map in the atlas. Insert the directions of the chief Roman roads as shown in your History text-book.) You will find that as far as possible the Romans avoided the low-lying marshy ground near the rivers, even when to do so they had to

make long detours. Where it was not possible to avoid the low-lying ground, their roads were raised well above the level of the surrounding country, with the object of having a road which could be used in all weathers as well as that of avoiding surprise.

London was not, as it is now, the chief centre of roads. The chief places from which roads radiated were Salisbury, with roads leading to Dorchester, Winchester, Bath, London, and Cirencester; Cirencester, linking Exeter, Dorchester, Winchester, Caerleon, and Carmarthen with Colchester and Leicester; Wroxeter (near Shrewsbury), connecting Caerleon, Carnarvon, and Chester with all parts of England. Places near Rugby, Tamworth, Lichfield, Leicester, and Derby were important junctions, from which roads radiated to all parts of Britain under Roman control. Manchester, Derby, and Lincoln controlled the roads leading to the Roman wall. Cross-Pennine routes were commanded by Ilkley (Aire Gap) and Catterick (Swaledale).

The Yorkshire roads avoided the marshy vale of York and kept to the Wolds from North Ferriby to Whitby and Flamborough, and to the rising ground in the west through Doncaster and Catterick, continuing in Durham through Bishop Auckland and Lanchester and crossing the Tyne at Corbridge. This road is well to the west of the present main road through Doncaster, York, Darlington, and Newcastle, which follows the river valleys, which were in Roman times too much covered with marsh and forest to be suitable for road-building. In the more hilly parts of the country the Roman roads did not always follow the ridges but crossed the Pennines at their natural gaps.

After the Romans had evacuated Britain the roads were no longer maintained in perfect order, and during the Middle Ages, as there was very little trade between towns, and consequently no long-distance wheeled traffic, the roads gradually got worse, and it was not until shortly before the Industrial Revolution that the existing roads were decently repaired and

new ones made. The existence of land beacons and lantern towers in churches is evidence of the lack of good roads throughout mediæval times.

The great era of road-building was from 1750 to 1820. The 1745 rebellion made necessary the existence of pioneers among the soldiers, whose chief duties were to construct roads for the passage of transport and artillery. "Blind Jack" Metcalf of Knaresborough constructed many fine roads in the north of England, while Telford, by making a series of good roads in the Highlands, revolutionized the social conditions of the Highlanders—*e.g.* before he had taught his labourers how to use tools the peasants had used crooked sticks with iron tips instead of ploughs, while wheeled vehicles and carts could not be used where there were no roads, so that neither agriculture nor trade could be said to exist except in a very primitive form. It would have been a good thing for the Highlanders if the Romans had extended their conquest of Britain to the Scottish Highlands. Telford did a similar work in Wales, and by the beginning of the nineteenth century England and parts of Scotland were covered by a network of turnpike roads centred on Birmingham, the tolls of which helped to pay for their upkeep.

Heavy rollers were used in making roads early in the nineteenth century, and made it possible to use small angular stones in the construction of macadamized roads. From 1820 to the present time the road system of the British Isles has improved, so that now wheeled traffic can go anywhere, in the British Isles.

Prior to 1750 most of the traffic on the roads was conducted by pack-horses, and wheeled vehicles could not be used successfully for long journeys. The stage-coach and post-chaise were employed from the beginning of the eighteenth century for passengers and goods on the main roads, but such traffic was extremely slow—*e.g.* the coaches running from the Black Swan, Holborn, to the Black Swan, York, were advertised thus: "The passengers may be received in a stage-

coach every Monday, Wednesday, and Friday, which performs the whole journey in four days, and sets forth at five in the morning." Such a journey nowadays takes about four hours. By 1770 the roads had improved, and by relays of horses the journey was reduced to two days. Before 1825 the distance was covered in twenty-one hours. The advent of railways killed the coaching trade, and by 1842 the main coaching routes were disused.

As early as 1831 Trevethick had taken out a patent for a steam road locomotive, but, though a primitive steam car was placed on the road by 1851, Acts of Parliament were passed to prevent the development of road engines, and till quite recently steam rollers had to be preceded by a man walking and carrying a red flag. Since 1900 a tremendous road transport industry has been built up. Electric, steam, and petrol cars are employed to carry both passengers and goods, and relieve the railways of much traffic—*e.g.* it is possible to travel from Leeds to Blackpool by tramcar, from Bishop Auckland to Newcastle by motor bus, and from the centre of London to Aldershot and Farnham and to Gravesend by tram and bus. The roads are once again highways of passenger and goods traffic, though as yet road traffic is supplementary to that of the railways.

(2.) Canals.

Something has already been said about the development of canals in Chapters III. and VIII., in which it was pointed out that though canals proved an aid to the industrial progress of England during the early years of the Industrial Revolution, the development of railways with speedier goods traffic prevented the extensive development of canals. It was also pointed out that the flatness of the European plain from France and Holland to Prussia and Poland facilitated canal construction on a much greater scale than was possible in the British Isles.

The amazing success of the Bridgewater Canal (1761),

whereby Manchester secured a cheap and plentiful supply of coal from the colliery at Worsley, and a capital expenditure of £220,000 gave an annual income of as much as £80,000, led to the construction of canals in many places. The British canals effected an improvement in communications comparable with that caused by the railways. Goods could be carried cheaply and much more quickly than was possible over the wretched roads—*e.g.* it was often impossible to drag a wagon from Manchester to Liverpool.

The value of the Bridgewater Canal was so apparent that Wedgwood and other makers of pottery helped to finance the Grand Trunk Canal from the Mersey to the Trent. The canal system was soon extended from the Trent to the Thames by the Oxford and Grand Junction Canals. The advantage of weight of merchandise carried and low cost of transport has enabled the canals of the Midlands to compete successfully with the railways to the present day, though the railway companies have to a great extent eliminated competition by buying up the canals and allowing them to fall into disuse. As the canals were made in order to get rid of the necessity for pack-horses as a means of carrying goods, they are too small for anything except barges. The dimensions of the older canals are as follows :—

Canal.	Date of Construction.	Length.	Breadth.	Depth.
		Miles.	Feet.	Ft. Ins.
Sankey Canal	1755	12	48	5 7
Leeds and Liverpool	1770	108	42	5 0
Basingstoke	1778	37	38	5 6
Thames and Severn	1783	30	42	5 0
Gloucester and Berkeley	1793	16	70	18 0
Grand Junction	1793	90	43	5 0
Kennet and Avon	1794	57	44	5 0
Aberdeenshire	1796	18	23	3 6
Thames and Medway	1800	8	50	7 0
Caledonian	1803	23	40	20 0
Rye or Royal Military	1807	30	72	9 0
Manchester Ship Canal	1894	36	300	26 0

Thus it is obviously impossible to use modern ocean-going vessels on most of the canals. If canals were constructed wide enough and deep enough for sea-going ships, and led from the estuaries to important inland industrial towns, the cost of carriage on many articles would be lessened.

Manchester Ship Canal enables Manchester to act as a port. The same thing could be done on the Severn and Yorkshire Ouse, making ocean ports of Gloucester and York, were it not for the fact that both of these towns have built locks too small to accommodate ocean-going vessels. By canalizing the flood-plains of rivers economies could be effected and the cost of transport cheapened. Most of the existing canals can only be used at present for barge traffic in coal, timber, iron, pottery, bricks, sand, and gravel. Ship canals, on the other hand, effect a saving when their locks are big enough. The locks of the Caledonian Canal are only 170 feet long and 40 feet wide. This prevents its use by large modern ocean-going boats. The Forth and Clyde Canal suffers from the same disadvantage that it cannot accommodate sea-going ships. The construction of a deep and wide canal between the Forth and the Clyde (35 miles) would be extremely useful, both from a commercial and from a strategic point of view.

In 1914 the railway-owned canals came under Government control, and in 1917 the Board of Trade obtained control of most of the privately owned canals, with the object of organizing the traffic on the canals to relieve the congested condition of the other means of transport. A large amount of trade is still carried on by the Birmingham Canals, the Aire and Calder Navigation, the Bridgewater Canals, and the Leeds and Liverpool Canal, particularly the transport of coal in the Birmingham district.

The uncontrolled canals are: The Basingstoke Canal (Aldershot, Woking, Byfleet); the Somerset Canal (from near Radstock to the Avon between Bradford and Bath); the Thames and Severn Canal; the Thames and Isis Navigation (between Stroud, Cirencester, Cricklade, Lechlade, and Oxford);

the Wilts and Berks Canal, which joins the Kennet and Avon Canal between Bradford and Devizes and passes through Swindon and Wantage to Abingdon on Thames; the Lea Navigation (from Hertford and Bishops Stortford through Waltham Abbey to Limehouse).

Others are the Great Ouse, Nen, Welland, and Fen district canals from Sleaford to the Witham, from New Bolingbroke, Lincs, to Boston, from Spalding and Bourn to the mouth of the Welland and to Boston-Black Sluice Drainage, from Peterborough to Wisbech and the mouth of the Nen, from Peterborough to March (Whittlesey Dyke).

The Bedford Level connects St. Ives with Downham. Canals extend from Cambridge and Bury St. Edmunds to Ely, from Northampton to Peterborough, from Stamford to Spalding, from Oakham to Leicester, the Whin Dyke from Brigg to the Humber.

The Louth Navigation joins Louth to the Humber near Grimsby; the Ouse Navigation (from Boroughbridge to the Humber); the Weighton Canal (from Market Weighton to the Humber); the Derby Canal (from Derby to the Trent); the Manchester Ship Canal (from Eastham through Runcorn to Manchester); the river Severn (from Shrewsbury to Stourport); the river Bann (from Lough Neagh to its mouth); the mouths of the Nore, Barrow, Suir, and parts of the river Erne.

The controlled canals are: The Shannon, with the Grand Canal (from Ballinasloe to Tullamore and Robertstown, and from New Ross on the river Barrow to Robertstown, and thence to Dublin) and the Royal Canal (from the Shannon and Longford to Mullingar and Dublin); the Ulster Canal, from Upper Lake Erne through Monaghan to Lough Neagh, and thence by the Lagan Canal to Belfast, and by the Newry Canal through Portadown to Carlingford Lough (Greenore and Newry).

Those in the North of England are the Leeds and Liverpool Canal; the Aire and Calder; the Wakefield, Barnsley,

Swinton, Sheffield, Goole, Thorne, and Trent Canals; the Leicester, Ilkeston, Grantham, and Gainsborough branches of the Trent Navigation between the Potteries and Trent Falls; the Foss Dyke, connecting the Trent with the Witham at Lincoln; the Chesterfield Canal, connecting Chesterfield with the Trent near Gainsborough; and the Kendal and Lancaster Canals (from Kendal through Carnforth and Lancaster to Preston).

The Midland Canals are the Shropshire Union Canals (from Newtown and Welshpool, Llangollen, Wolverhampton, Shrewsbury and Market Drayton to Nantwich and Chester); the Stafford and Worcester Canal (from Cannock, Stafford, and Wolverhampton to Kidderminster and Worcester); the Birmingham and Worcester Canals (from Tamworth to Birmingham, Wolverhampton, Dudley, and Worcester); the Warwick and Birmingham Canal, continued to Oxford as the Oxford Canal; the Stafford and Avon Canal (from Birmingham to Stratford); the Ashby Canal (from Burton to Market Bosworth and Coventry); the Coventry Canal (from Tamworth to Nuneaton and Coventry); the Grand Junction Canal (from Leicester to Market Harborough, Northampton, Bletchley, and Leighton Buzzard, and to the Thames at Brentford and at Limehouse, being joined by small canals from Buckingham, Aylesbury, Wendover, and Slough); the Kennet and Avon Canal (connecting Avonmouth, Bristol, Bath, Bradford, Devizes, Newbury, and Reading); the Gloucester and Berkeley.

The remaining canals are the Brecon-Abergavenny-Pontypool-Newport Canal; the Glamorganshire Canal (from Merthyr-Tydfil and Aberdare to Cardiff); the Swansea Canal (from the Brecon district through Clydach to Swansea); the Thames and Medway (from Gravesend to Strood); the Caledonian; and the Forth and Clyde Canal.

(3.) Railways.

The early railways were constructed to facilitate transport between Darlington and Stockton in 1825, and between

Liverpool and Manchester in 1828. Neither was originally intended for steam locomotives, but for coaches drawn by horses. As a speed of 29 miles an hour was attained by the *Rocket* at the opening of the Manchester-Liverpool railway, the value of railways for rapid transport was seen, and local committees began to finance small railways in the northern counties.

The gauge 4 feet 8½ inches was adopted to suit that used in the colliery wagons, and 4 feet 8½ inches became the standard gauge for the northern railroads. In a similar way the size of the original locomotives and coaches limited the size of tunnels and cuttings, with the result that British railway engines, coaches, and trucks could only increase their capacity by increasing the length of engines and vehicles.

The Great Western line, however, was not built for coal export, and adopted a broad gauge, 7 feet, which would have made it possible to build bigger engines and trucks than the 4 feet 8½ inches gauge. The railways, however, spread from the collieries of the north to the more open plains of the south of England, and this made it necessary for the Great Western Railway to abandon its broad gauge and come into line with the smaller gauge and rolling stock of the north. It is worth noting that some of the modern American trains are twice the size of the British trains, with more powerful engines and huge cars for carrying goods.

Construct a map of the main railway lines on transparent paper to the same scale as the physical features map in your atlas, and find to what extent the physical features determine railway routes in the United Kingdom.

It was not only topography which determined the present railway main lines. The original lines were from the coalfields to the ports and to industrial centres—*e.g.* the Manchester-Liverpool line (1828), the Leeds-Selby line (1834), and the Darlington-Stockton line (1825). The Tyneside collieries were connected to the river, Sunderland to Durham, and so on.

The lines from north to south grew up gradually and in

a more or less haphazard manner—*e.g.* it was the formation of a "Great North of England Railway Company," which proposed to construct a line from London through Leeds to Newcastle, that roused the people of York to their need for a railway connecting York with the Leeds and Selby line, and thus through Derby with London. Thus the York-Milford Junction Railway was opened in 1839, and put York in connection with the South Yorkshire coalfield, Leeds, and London, the route being approximately that followed by the old Roman road along the moraine which crosses the vale of York. In 1841 the Darlington-York section of the east coast route was opened, bringing coal from the Wear Valley to York. In 1844 the Newcastle-Darlington Railway was opened.

By 1845, George Hudson, the promoter of the north-east coast railways, had succeeded in organizing the north-eastern railways so that £100 railway shares were worth £250. Hudson's great aim was to avoid competition by the amalgamation of railways and by leasing competitive lines. Dividends in the companies he controlled ranged from 10 per cent. to 15 per cent., with the result that from 1845 to 1849 the number of railways projected increased enormously. Panic and reaction followed, and Hudson was ruined, but not before Britain was covered by a network of railways which gave her the best system of communications in Europe.

During the past twenty years electric railway systems have been worked successfully. Not only do light railways for tramcars exist in all considerable towns, but most of the suburban railways of London have been electrified. The Brighton and South Coast Railway is electrifying a line from London to Brighton; the Midland Railway from Lancaster to Morecambe and Heysham, the North-eastern Railway in the Newcastle district, and the goods line from the collieries in the Bishop Auckland area to the Tees mouth are in successful operation.

The Great War revealed the fact that private enterprise had failed to provide an ideal transport system, so it has been

decided to bring roads, railways, and canals under Government control. During the War the loss under private enterprise was £90,000,000 per annum, an amount which equals the pre-war earnings of our overseas carrying trade. Railways before the war returned 4.2 per cent., and afterwards their loss was 3 per cent. to 4 per cent. Light railways returned 2 per cent., but after the war they were worked at a loss. Canals before the war earned 1½ per cent. (excluding the Manchester Ship Canal). The roads had no income, and cost £20,000,000 a year to maintain. Harbours and docks were half owned by the railways, and the privately owned terminal points of our great export and import trades were in the hands of the dock authorities and other terminal owners, whose interest was not to spend money on improving the terminal accommodation when the advantage would go to the conveying companies. The consequence was that improvements, such as increasing the size of trucks, could not be made, very largely on account of the inability of the terminal points to take the traffic.

The nation could not afford to allow the old system to continue, so a Ministry of Transport has been set up to control and organize the roads, railways, and canals, the railway systems to be electrified as far as possible.

MAIN RAILWAY ROUTES.

The Great Eastern Railway.

(*a*) The main line is from *London* (Liverpool Street) through *Bishops Stortford*, *Cambridge*, *Ely*, *March*, *Spalding*, *Sleaford*, *Lincoln*, *Gainsborough*, and *Doncaster*, with running powers to *York*.

(*b*) The coast-line is from *London* (branch from Fenchurch Street to Southend) through *Chelmsford*, *Colchester* (branch to Clacton and to Harwich), *Ipswich* (branch through Stowmarket to Haughley, where there are connections to Norwich

and to Bury St. Edmunds and Ely), *Lowestoft, Yarmouth,* and *Norwich,* where lines enter from Ely, King's Lynn, and Cromer.

(*c*) *Thetford, Bury St. Edmunds,* and *Sudbury* are linked by an intermediate line running from *King's Lynn* to the coast-line near *Colchester.*

There are railway works at Stratford. The importance of the railway in the development of the towns of the eastern counties has been noted in Chapter IX.

The East Coast Routes.

(*a*) **The Great Northern Railway** runs from *London* (King's Cross) through *Hatfield* (branches to Hertford, St. Albans, and Dunstable), *Hitchin* (branch to Cambridge), *Huntingdon, Peterborough* (branches to Leicester and through Market Harborough to Northampton), *Grantham* (branches to Sleaford, Boston, the Lincoln coast, and Grimsby, to Nottingham, and thence with running powers through Derby to Stafford over the North Stafford Railway), *Newark, East Retford* (junction with Great Central Railway, with running powers to Sheffield, Penistone, Manchester, and Liverpool), *Doncaster* (branch through Wakefield to Leeds and Bradford), where it has running powers through York to Edinburgh on the North-eastern Railway. The Great Northern Railway locomotive works are at Doncaster and Peterborough.

(*b*) **The North-eastern Railway** main line begins a few miles north of *Doncaster,* and passes through *Selby* (branches from Leeds, Goole, Hull, Market Weighton, and Bridlington), *York* (centre of North-eastern Railway system, with connections with the Midland Railway at Sheffield, with the Lancashire and Yorkshire Railway at Normanton, with the London and North-western Railway at Leeds, and with branches to Harrogate, Market Weighton and Hull, Malton and Scarborough and Whitby), *Thirsk* (branch from Ripon and Leeds), *Northallerton* (branches from Leeds and Ripon,

Eaglescliffe, connecting with the North Yorkshire coast at Middlesbrough and with the Coast Railway of Durham from Stockton through Hartlepool to Sunderland and South Shields, with Hawes on the Midland Railway on the west of the Pennines), *Darlington* (branch lines to Middlesbrough, Stockton, and Hartlepool, and to Barnard Castle, Kirkby Stephen, Appleby on the Midland Railway, to Penrith on the London and North-western Railway, with running powers to Keswick and the Cumberland coast, from Kirkby Stephen to Tebay on the London and North-western main line, and to Bishop Auckland and the upper valleys of the Wear and South Tyne), *Ferryhill* (branches to Bishop Auckland, Stockton, Hartlepool, and Sunderland), *Durham* (branches to Consett, and Blaydon on Tyne, and to Sunderland), *Newcastle* (branches to Carlisle and along the Northumberland coast), *Alnmouth*, with a branch to the Tweed valley at Coldstream, Berwick. Beyond this the North-eastern Railway has running powers over part of the North British Railway to *Edinburgh* and *Glasgow*. The locomotive works of the North-eastern Railway are at Darlington and Gateshead.

(*c*) **The North British Railway** continues from *Berwick*, where it receives a branch from St. Boswells (near Melrose), which is connected through Hawick with Carlisle and through Galashiels with Edinburgh (Waverley route), *Dunbar*, *Edinburgh*, where branches run to Stirling and through Glasgow to Fort William and Mallaig. The main line crosses the *Forth Bridge* to *Inverkeithing* (branch to Perth), *Kirkcaldy*, *Cupar*, and crosses the *Tay Bridge* to *Dundee*, continuing through *Arbroath*, *Montrose*, and *Stonehaven* to *Aberdeen*.

(*d*) **The Great North of Scotland Railway** connects *Aberdeen* with *Banff* and *Elgin*, Peterhead and Fraserburgh being connected to Aberdeen. This line is not important as a main route, because the Highland Railway provides a shorter line to Inverness.

(*e*) **The Highland Railway** runs from *Perth* to *Blair Atholl*, *Dalwhinnie*, *Kingussie*, *Aviemore* (branch to Elgin), *Inverness*,

Dingwall (branch to Strome Ferry and Lochalsh), *Wick*, and *Thurso.*

The West Coast Routes.

(*a*) **The Midland Railway** runs from *London* (St. Pancras) through *St. Albans, Luton, Bedford* (branch to Hitchin and Northampton), *Wellingborough, Kettering* (branch to Huntingdon). Two branches leave Kettering (1) through *Leicester, Derby, Matlock, Buxton, Manchester* and *Liverpool*, and (2) through *Nottingham, Chesterfield* (branch to Matlock), *Sheffield, Leeds, Hellifield* (branch with running powers to Liverpool), *Settle* (branch to Carnforth and to Morecambe and Heysham), *Hawes Junction, Kirkby Stephen, Appleby*, and *Carlisle*, with running powers over the North British line to *Edinburgh*, and over the Glasgow and South-western Railway to *Glasgow. Derby* is the centre of the Midland Railway system, and connects *Burton-on-Trent* (branch to Leicester), *Tamworth* (where it crosses the London and North-western Railway), *Birmingham* (branch to Walsall and Wolverhampton), *Bromsgrove, Worcester* (branch to Malvern, Hereford, with running powers through Brecon to Swansea), *Cheltenham* (where a joint Midland and London and South-western line connects with Cirencester, Andover, Southampton, and Portsmouth), *Bristol, Bath*, and thence over the London and South-western Railway line to Templecombe and Bournemouth.

(*b*) **The Glasgow and South-western Railway** runs in connection with the Midland Railway from *Carlisle* through *Dumfries, Sanquhar, Cumnock, Kilmarnock*, and *Glasgow.* A coastal line through Castle Douglas (branch to Kirkcudbright), Newton Stewart (branch to Wigtown), Stranraer, and Portpatrick, and along the west coast through Girvan, Ayr, Ardrossan, Paisley, Greenock, to Glasgow, collects the local traffic of south-western Scotland.

(*c*) **The London and North-western Railway** connects *London* (Euston) with *Watford, Leighton, Bletchley* (branches

to Oxford and Cambridge), *Blisworth* (branch to Northampton), *Rugby* (branches through Market Harborough to Stamford and Leicester, through Coventry to Birmingham, and to Northampton), *Nuneaton, Tamworth,* and *Lichfield* (branches to Walsall, Dudley, and to Birmingham), *Stafford* (branch from Birmingham and Wolverhampton, and from Shrewsbury), *Crewe* (the centre of the system, with lines through *Shrewsbury,* Craven Arms, Llandilo to *Swansea,* Carmarthen, Pembroke, and Cardigan, through *Chester,* Flint, Bangor to *Holyhead,* through *Manchester* to *Leeds*), *Warrington* (branches to Liverpool and Manchester), *Wigan, Preston* (running powers to Fleetwood), *Lancaster, Carnforth, Shap, Penrith,* and *Carlisle,* where it connects with the Caledonian Railway.

(*d*) **The Caledonian Railway** continues from *Carlisle* through *Carstairs* (branch to Edinburgh), *Motherwell* (branch to Coatbridge), *Airdrie, Falkirk, Stirling, Perth, Forfar* (with running powers through Montrose to Aberdeen), *Glasgow,* and *Greenock.* A branch line connects Stirling with Oban.

Cross-Pennine Routes and Small Lines in the North Midlands.

(*a*) **The Lancashire and Yorkshire Railway** is the most important Lancashire railway. Its main line connects *Liverpool* with *Manchester, Oldham, Rochdale, Todmorden, Dewsbury* (branch to Barnsley), *Wakefield* (running powers to York, branches to Doncaster and Sheffield), *Pontefract, Goole* (branch from Doncaster), and *Hull.* Manchester is the headquarters, and is connected with all the chief Lancashire towns, through Preston with Fleetwood and Blackpool, and through Bury, Burnley, Colne, Skipton, and Shipley with Leeds and Bradford.

(*b*) **The Great Central Railway** does not own all the lines over which its trains run. Its main line is from *Liverpool,* through *Manchester, Penistone, Sheffield, Worksop* (branch to Mansfield), *Retford, Gainsborough,* to *Grimsby.* Its London

line runs through *Sheffield, Nottingham, Loughborough, Leicester, Rugby, Aylesbury* or through *High Wycombe* to *London* (Marylebone).

(*c*) **The North Staffordshire Railway** connects *Macclesfield* with *Stoke-on-Trent, Burton,* and *Nottingham.*

The Great Western Railway.

(*a*) The main western line leaves *London* (Paddington) for *Reading, Didcot, Swindon* (locomotive works), the *Severn Tunnel, Newport, Cardiff, Swansea, Carmarthen,* and *Fishguard.* A branch leaves Swindon through Chippenham for Bristol, Bridgwater, and Taunton.

(*b*) The south-western branch connects *Reading* with *Westbury, Taunton, Exeter, Newton Abbott* (branch to Dartmouth), *Devonport, Truro* (branch to Falmouth), and *Penzance.* A branch leaves this line at Castle Cary for Yeovil and Weymouth.

(*c*) The north-western branch runs from *London* through *High Wycombe, Banbury, Warwick, Wolverhampton, Shrewsbury, Ruabon* (branch to Dolgelly and Barmouth), *Chester,* and *Birkenhead.*

Manchester, Crewe, Shrewsbury, Hereford, and *Newport* are also served by a continuous line.

The South Coast Routes.

(*a*) **The London and South-western Railway** serves the south coast between Portsmouth and Plymouth. *London* (Waterloo) is the terminus. *Woking* is the junction of the *Guildford, Godalming, Haslemere, Petersfield, Havant, Portsmouth* line and the line through *Aldershot, Farnham, Alton, Winchester, Eastleigh, Southampton,* and *Bournemouth,* while the south-western branch connects *Woking, Basingstoke* (main line through *Winchester* to *Southampton*), *Andover, Salisbury, Yeovil Junction, Honiton, Exeter,* through *Crediton,*

round the north of Dartmoor to *Plymouth*. A cross-*Channel* route connects Southampton to Havre, Dieppe, and the Channel Islands.

(*b*) **The London, Brighton, and South Coast Railway** runs from *London* (Victoria) through *Croydon*, *Redhill*, through the *South Downs* to *Brighton*. The coastal line connects Portsmouth, Havant, Chichester, Worthing, Brighton, Lewes (branch to Newhaven, Eastbourne, and Hastings). The London-Portsmouth line passes through Dorking, Horsham (branch to Tunbridge Wells), through the Arun Gap to the coast-line near Littlehampton.

(*c*) **The South-eastern and Chatham and Dover Railway** passes from *London Bridge* through either (1) *Bromley* and *Rochester*, or (2) through *Dartford*, *Gravesend*, *and Strood* to *Chatham*, *Sittingbourne* (branch to Sheerness), *Faversham* (branch through Whitstable, Margate, and Ramsgate), *Canterbury* (branches to Ashford and St. Leonards and to Ramsgate), and *Dover*. The *Folkestone* line connects *Charing Cross* with *Sevenoaks*, *Tonbridge*, *Ashford*, and *Folkestone*. Maidstone is connected with Ashford, Rochester, and Sevenoaks, while a line runs through Reading, Farnborough, Guildford, Dorking, Redhill, Tonbridge, and Ashford to Folkestone.

Railway Steamer Routes.

Mention has already been made of the London and South-western Railway cross-Channel service. The London, Brighton, and South Coast Railway has steamer connections between *Newhaven* and *Dieppe;* the South-eastern and Chatham and Dover Railway between *Dover* and *Calais* and *Ostend*, and between *Folkestone* and *Boulogne;* while it is possible that the Channel ferry for trains between *Richborough* and *France* will be retained in peace time. Though the Midland Railway has through connections with Tilbury Docks, it does not at present run steamer services with the Continent, though the Great Eastern Railway has a service

through *Harwich* to *Denmark, Hamburg, Rotterdam,* and *Antwerp.* The great Central Railway maintains about nineteen steamers between *Grimsby* and *Hamburg, Rotterdam,* and *Antwerp.* The Lancashire and Yorkshire Railway owns boats with both goods and passenger accommodation sailing to *Hamburg, Rotterdam,* and *Copenhagen* from *Goole,* while from *Fleetwood* and *Liverpool* there is a very large traffic with the *Isle of Man, Belfast, Dublin, Drogheda, Newry,* and several other Irish ports. The Midland Railway has sailings to the *Isle of Man* and the chief Irish ports from *Heysham,* and to *Havre* from *Weymouth.* The Glasgow and Southwestern Railway has connections between *Stranraer and Larne.* The London and North-western Railway has access to the docks at Poplar and Victoria Docks, a mail-boat service between *Holyhead* and *Dublin,* as well as connections with the *Channel Islands, Rouen, the Isle of Man,* and *Ireland.* The Great Western Railway controls the traffic between the *Scilly Isles* and *Penzance,* between *Bristol* and the south of *Ireland,* and between *Fishguard* and *Rosslare.* Steamers are run between *Gourock* and the Hebrides and Caledonian Canal in connection with the Scottish railways, as well as between *Glasgow* and *Belfast* and *Londonderry,* and between *Belfast* and *Ayr.*

Irish Railways.

The Great Western Railway runs in connection with the **Great Southern and Western Railway** of Ireland and the Dublin, Wicklow, and Wexford Railway. *Rosslare* is connected with *Wexford, Waterford, Dungarvan, Mallow, Killarney,* and *Cork.* *Sligo* is connected through *Athenry, Limerick,* and *Tipperary* with *Mallow* and *Waterford,* while the main line of the Great Southern and Western Railway runs from *Dublin* through *Kildare* and *Maryborough* to *Limerick* and to *Tipperary.*

The Midland Railway runs in connection with the **Great Northern Railway** of Ireland, but owns the **Northern Counties**

of Ireland Railway from *Belfast* to *Ballymena, Coleraine* to *Londonderry*, the Great Northern Railway of Ireland connecting *Londonderry, Strabane, Omagh, Dundalk* (branch to Lurgan and Belfast), *Drogheda*, and *Dublin*.

The Midland and Great Western Railway of Ireland runs due west from *Dublin* through *Mullingar* (branch to Longford and Sligo), *Athlone* (branch to Castlebar and Killala), to *Galway* and *Clifden*.

CHAPTER XVI.

TRADE.

TRADE has been carried on since very early times, when it consisted of exchange of their foodstuffs between tribes living in different regions. To this day such barter is the chief method of trade in such places as savage Papua, where the fishers of the coast exchange their catches for animal food obtained by the hunters inland. That trade is exchange is illustrated by the condition of Russia under the Bolshevists, paper money becoming valueless and English Treasury Notes less acceptable to the Russians than food, tobacco, or articles of clothing.

MONEY.

For long ages trade was conducted by barter. There were, however, rare and useful metals which were of almost equal use to people in different regions, and the habit of using metal coins originated. Copper and silver coinages existed throughout the Old World from China to Greece, and the tremendous extension of Roman power made the Roman coinage a suitable token of exchange. Iron, though valuable, was useless as coinage, and gold, silver, and copper, which do not rust, were adopted in civilized countries as money. Thus it was no longer necessary for a man who wanted cattle in exchange for fish to go first to the neighbour who needed fish in exchange for corn, and then to the cattle-seller who needed corn. Money simplified trade.

As a rule the making of coins was controlled by the governments of countries. When unwise kings desired to create wealth they frequently debased the coinage, and so thought to become richer. It must always be remembered that metal coins are merely *tokens* of exchange, and that the metal itself does not constitute wealth. As soon as trade between different countries grew up, debased coinage fell to its true value. It took England some time to realize this, and it was not till after the merchants of the Hanseatic League demanded true value for their goods that the English realized that for international trade the money currency should have full value. The Hansa traders demanded weight for weight, and their coins, which were always heavy and sent down the scales with a bang, impressed the English with the idea of (Ea-)sterling value. Money fluctuated in value according to the supplies of the metals, gold, silver, and copper, and this fluctuation made it imperative to fix some international standard of coinage. Gold, which was formerly the rarest metal, was adopted as the standard, and it is because the English gold sovereign contains a sovereign's worth of gold that English coinage has been a universally accepted basis for trade with foreign nations.

Rates of Exchange.

The possession of gold, however, is not necessarily wealth. The Spanish believed that the accumulation of gold would give them unlimited wealth. They accumulated gold and neglected agriculture. Remember the legend of King Midas. Gold is neither food nor can it be used as a tool. Spain spent her gold unwisely in buying the commodities she was too lazy to produce, and is to-day one of the poorest countries in Europe. South Africa, which produces about 40 per cent. of the world's supply of gold, is not a wealthy nation. Gold is worth less where it is plentiful, and except as a token is useless. Unless, therefore, money represents goods or labour which are actually available, it is valueless. Thus, though an inter-

national gold standard exists, the relative value of the coins of different countries varies. A sovereign is worth about 25 francs, but if the real wealth a franc represents depreciates the sovereign may be worth as much as 28 francs. The U.S.A. dollar is ordinarily worth 4s. 2d., but if the English pound depreciates in real value the dollar may be worth as much as 4s. 8d. Thus we see that the rise and fall of the international rates of exchange give some indication of the real wealth possessed by countries, of which their coinages are but the tokens.

Wealth.

What is Wealth?—The possession of power which can be used is wealth. The chief sources of wealth are: (1) the *land*, from which are obtained fuel, useful minerals, plants, and animals of use in providing man with food, clothes, and shelter, and water-power, which can be made to supply energy; (2) the *sea*, with its food supply and its wasted energy—the tides; and (3) *man himself*, whose intelligence can direct and whose skill can be applied to convert the energy of (1) and (2) into forms useful to mankind.

Relative Wealth.—Though each man has by nature only his intelligence and physical skill, yet some people are more wealthy than others. This is due in a large measure to the use which men make of their brains. The possession of land gives to man the possession of a great source of wealth. With his own hands he can do little, but if he can induce others to develop his lands for him he is able to accumulate real wealth, though without labour ownership does not constitute wealth. Human beings appear to be naturally greedy, with the result that owners have endeavoured to keep as large a proportion of the wealth as those who work for them will allow. Their superior brain power has rewarded them with superior wealth, though where the distribution of wealth has been iniquitous ownership has sometimes been a source of danger to those who controlled the sources of wealth (*cf.* the

French and Russian revolutions). While the owners of the sources of wealth in Britain have not been so overbearing as to cause a revolution against the economic system of the country, the kingdom, by unjustly exploiting the people of the New England States, caused what is now the U.S.A. to break away from the British Empire.

Bills of Exchange and Banking.

There is another form of ownership which has become important—the ownership of money. The system of credit —*i.e.* purchase on promise of payment—is of ancient origin (*cf.* the system by which accounts were kept by tally in the Middle Ages, which was a form of credit transaction). The inconvenience and danger of carrying sums of money between towns frequented by robbers, or on seas haunted by pirates, induced merchants who trusted each other to accept written acknowledgments of indebtedness.

Honesty with other nations in trading transactions made English paper money and bills as valuable in Pekin and Peru as in London itself. Thus, as time went on, the transhipment of gold in payment for goods became unnecessary, and trade is now carried on very largely by means of bills of exchange, which can be cashed in any civilized country. Thus goods imported into this country from the U.S.A. are frequently paid for by bills for goods exported from this country to Canada or South America. Such a system of paper acknowledgments depends on (1) the establishment of banks with sufficient reserves of cash to pay bills which may be presented for payment ; and (2) on the mutual trust between the bankers.

British commerce owes a very great deal to the establishment of the Bank of England in William III.'s reign, with its strong reserve of gold to strengthen the British rate of exchange. The result of the centralizing of the power of British money in the Bank of England has been to make English credit the soundest in the world.

There are, however, small defects in the English banking system. English bankers are chiefly concerned with the security offered in return for the loan of the cash they control, with the result that it is difficult for a man to borrow money to start a new industry unless he has some security in land or shares to offer as a pledge. The German system, on the other hand, makes it possible for a man with an idea for producing wealth to approach a bank, which, if it thinks the idea sound, will advance money to give the new undertaking a trial. In this way Germany built up many industries which could not have been begun in Britain for lack of capital.

Banking and International Trade.

It is not likely that individuals will be satisfied with unequal exchange, yet every year the value of British imports is more than 100 million pounds greater than that of British exports. *How is this?* The value of the imports includes (1) the charge for carriage from other countries to this—*i.e.* the value of a cargo increases as it crosses the sea; (2) the profits of the wholesale merchants who distribute the goods; and (3) foreign capital invested in Britain. This does not explain a large proportion of the deficit. *How is this deficit paid?* (1) By the profits of the carrying trade, which British ships still largely control; (2) by the investment of British capital in foreign countries; and (3) by payments in gold sent overseas. The re-establishment of Britain's trade will depend (1) on the development of overseas trade with our Colonies; with China, which is being induced to adopt the gold standard of exchange; with South America, which is relatively undeveloped; and with tropical regions generally, where the cultivation of the coco-nut palm is capable of immense development; (2) on the re-establishment of a merchant shipping capable of retaining our enormous pre-war carrying trade; and (3) on the development, which the Government will probably in some measure control,

of the staple industries, agriculture, textiles, coal-mining, and shipping, and of the "key" industries in the electrical, chemical, metal, and engineering trades.

Development of British Trade.

The development of communications brought England into contact with the Continent. English wool was exchanged for the wine of Bordeaux and the cloths of Northern France and Belgium, giving rise to roads from London to Southampton and the Cinque Ports, and from Paris to the coasts of Normandy, Brittany, and Aquitaine, and to a cross-Channel trade. The communications between the estuaries of the east coast and the mouths of the Rhine and the rivers of Belgium and Germany, whereby the wool and lead of England were exchanged for the cloth and iron goods of Belgium and Germany and the furs of Prussia, became increasingly important during the Middle Ages, being developed by the Hanseatic Federation, by the Danes and the Dutch, and by the Merchant Adventurers of England.

The discovery of the ocean routes to America and India destroyed the commercial power of Venice and Genoa in the Mediterranean, and gave to Spain and Portugal a monopoly of oceanic trade which they were too weak to maintain. The Dutch, the Danes, the French, Swedes, Norwegians, and the British established trading relations with Japan, India, Muscovy, the Americas, and parts of Africa.

England's great wealth, her political unity, and her relatively dense population made it possible for her to become the supreme naval power in succession to Spain, and after defeating the Dutch, the first British Colonies were established with the purpose of exploiting the new possessions for commercial gain. The wealth accumulated made England the world's richest nation, but rather too keen on money-making.

The overseas trade was built up by private enterprise, Bristol, Liverpool, Greenock, Gravesend, and York sharing

FIG. 68.—Map showing the Natural Regions of the World. Compare this with a map showing the density of population in various parts of the world, and find out which places are capable of increased production of foodstuffs and raw materials when more fully developed.

with London the West Indian trade, Glasgow and its outports sharing the North American trade with Liverpool and Leith, the Scottish ports and Hull sharing the North Sea and the whale and other fishing trades, London with its outposts—Dover and Southampton—controlling the trade with Europe and India. Norwich and York decayed as vessels grew larger, though York had a considerable West Indian trade as late as 1840.

The Industrial Revolution commenced about 1750, and the country controlling the world's carrying trade was able to obtain supplies of all kinds of materials. The woollen industry was established on a new scale, but speedily gave first place to cotton ; the use of coal for smelting became general, and enabled England and Scotland to develop great engineering industries, while the great part of Europe was engaged in very few industries outside agriculture, and while America was not explored west of the Alleghanies, was overrun by savage tribes, and had no good roads. Communications developed most quickly in Britain, though the roads were not good before the Industrial Period. Canals were followed by railways, and Britain became the chief commercial and industrial country in the world.

France and Germany, with greater facilities for railway and canal construction, developed more slowly ; but France, with her large agricultural area, and Germany, with her enormous coal and iron resources, gradually began to rival Britain's commercial supremacy. The U.S.A., beginning later, but with much greater natural resources, developed more quickly, and is now the greatest industrial nation, and may become the greatest commercial country in the world.

Pre-war Foreign Trade.

America, Germany, India, and France were the chief nations trading with us, raw materials and food coming from all, and manufactured goods from the U.S.A., Germany, and France.

The U.S.A. sent us four times the value of what we returned, and Germany and France twice the value of the goods we exported to them.

The enormous resources of the U.S.A. will make her the greatest industrial nation, and during the Great War her financial indebtedness to us disappeared, and our indebtedness to her has increased, so that it is possible that the U.S.A. will become the greatest commercial country in the world. Germany and France, the third and fourth commercial countries of the world, will take some time to recover, but the United Kingdom will almost immediately resume normal trade conditions. India is the chief market for English goods, but the development of China and Siberia offer opportunities for English trade.

Imports.

Our chief imports are foodstuffs, raw cotton and wool, and manufactured goods.

(1.) Foodstuffs.

(*a*) **Grain.**—*Wheat* from the U.S.A., Argentine, British India, Canada, Russia, and Australia (Though the acreage under wheat in Britain has increased, it is unlikely that it will remain more than one-third of what is needed unless the Government control or subsidize agriculture);

Barley from Russia, India, U.S.A., Turkey, Rumania, and Canada;

Oats from Russia, Argentine, U.S.A., Germany, Canada, Chile, and Rumania;

Maize from Argentine, U.S.A., Rumania, Russia, British South Africa, Canada, and British India; and

Rice from China, India, Java, and Japan.

(*b*) **Meats.**—*Beef* (53 per cent. home supply) from Argentine, U.S.A., Australia, New Zealand, and Uruguay;

Mutton from New Zealand, Argentine, Australia, Chile, and Uruguay;

Bacon from U.S.A., Denmark, and Canada; and
Pork from Holland, U.S.A., Denmark, and Canada.

(*c*) **Dairy Produce.**—*Butter* from Denmark, Russia, Australia, France, New Zealand, Sweden, Holland, and Canada;

Cheese from Canada, New Zealand, Holland, U.S.A., and Italy;

Eggs from Russia, Denmark, Austria, Germany, Italy, France, Egypt, Holland, and Canada; and

Tinned Milk from Switzerland, Canada, Holland, France, and Norway.

(*d*) **Fruits.**—*Bananas* from Costa Rica and the Canary Isles;

Oranges from Spain and the Mediterranean;

Dates and *Figs* from Asia Minor and North Africa;

Apples from Nova Scotia; and

Tinned Fruits from California, British Columbia, Eastern U.S.A., and Singapore.

Wines from France, Portugal, and Spain.

(*e*) **Sugar** from Germany, France, and Holland; and **Cane Sugar** from India and Java.

(*f*) **Tea** from India, Ceylon, and China; **Coffee** from Brazil and Central America; and **Cocoa** from the West Indies.

(*g*) **Tobacco** from U.S.A. and from Holland.

(*h*) **Oil-seeds** for the manufacture of margarine and similar substitutes from U.S.A., India, Belgium, Germany, and Holland; **Palm Oil** from Nigeria and Germany; **Soya Beans** from Manchuria; and **Olive Oil** from Spain, Italy, and France.

(*i*) **Spices.**—*Cloves* from Pemba, the East Indies, and the Philippines;

Nutmeg from the East Indies and the West Indies;

Vanilla from the West Indies and Central America, from Mauritius, Madagascar, Seychelles, and the East Indies;

Ginger from India and Southern China and Siam; and

Pepper from the East Indies, French Indo-China, and Java.

(2.) Raw Materials.

(*a*) **Metals.**—*Gold* from South Africa, Australia, and the East Indies;

Silver from U.S.A., Germany, and France;

Lead from Spain, Australia, U.S.A., and Germany;

Lead Ore from Australia, New Zealand, Chile, Peru, Spain, and France;

Copper from U.S.A., Mexico, Spain, France, and Italy;

Zinc from U.S.A. and Belgium;

Platinum from Russia and Colombia;

Mercury Ores from Spain and Italy;

Nickel from Canada;

Iron Ore from Spain, Greece, Sweden, and the other Mediterranean countries; and

Tin from Straits Settlements, South America, and South Australia.

(*b*) **Mineral Oils** from U.S.A., Russia, Burma, Mexico, Persia, Rumania, and Galicia; and **Asphalt** from Germany, West Indies, France, and Italy.

(*c*) **Cotton** from U.S.A. (60 to 70 per cent.) and Egypt; **Flax** from Russia; **Jute** from India, the Philippines, and Mexico; and **Wool** from Australia, New Zealand, and South Africa.

(*d*) **Timber.**—*Furniture woods* from U.S.A., Australia, South Africa, and West Indies;

Teak from India, Siam, and Java;

Oak from U.S.A., Germany, Russia, and Canada;

Fir (sawn) from Russia, Sweden, Canada, Norway, France, and U.S.A;

Mahogany from Mexico and Honduras; and

Ornamental and Dye Woods from India, Burma, and East Indies.

(*e*) **Nitrates** from Peru and Chile, and from Norway.

(*f*) **Rubber** from Brazil, the Congo, and Malaysia.

(*g*) **Dyeing Materials** from the East Indies, France, Turkey, Italy, Natal, and Argentine.

(*h*) **Hides** from East Indies, Holland, Italy, Belgium, France, Germany, Argentine, U.S.A., Russia, South Africa, Australia, and Brazil.

VALUES OF IMPORTS AND EXPORTS OF RAW MATERIALS (AS GIVEN BY THE LAST CENSUS OF PRODUCTION).

	In Thousands of Pounds.	
	Imports.	Exports.
Coal and Coke	276	42,584
Iron Ore	6,208	409
Other Ores	8,418	115
Timber	27,583	323
Cotton	70,658	...
Wool	22,166	4,817
Other Textiles	13,777	475
Oil-seeds	32,097	4,568
Paper-making Material	5,325	927
Rubber	5,292	...
Hides	5,671	2,027

(3.) Manufactured Goods.

Machinery from Germany and U.S.A.

Motors from France and U.S.A.

Dyes from Germany.

Toys and **Musical Instruments** from Germany, France, and Japan.

Rubber Goods from U.S.A.

Woollens and **Silk Goods** from France.

Leather Goods from U.S.A. and Germany; and **Gloves** from France.

Clocks and **Watches** from U.S.A., Switzerland, and Germany.

Exports.

Our chief exports were :

(1.) **Manufactured cottons and woollens** to tropical and dry countries and to our own Colonies :

	Value in Thousands of Pounds.	
	Imports.	Exports.
Cottons	9,225	122,219
Woollens	8,845	37,773
Silk	1,242	2,225
Linens	2,646	9,685
Jute	1,442	3,535
Clothes	6,711	12,874
Paper	7,049	3,559
Wood Goods	2,557	2,058
Leather	13,070	9,541
Pottery and Glass	4,119	4,973
Chemicals	11,013	21,036

(2.) **Iron goods and machinery** to the Colonies, China, and South America :

	Value in Thousands of Pounds.	
	Imports.	Exports.
Iron and Steel	12,684	48,597
Other Metals	22,535	12,284
Hardware	5,368	8,108
Electrical Goods	1,231	4,341
Machinery	5,549	33,158
Motors	7,035	9,758
Ships	32	7,027

(3.) **Coal** to European countries, to South America, and to coaling stations on the great trade routes.

The value in thousands of pounds of our exports in 1913 was 73,400.

Our chief customers for coal were :

	Thousands of Tons.
France	12,775
Italy and Malta	9,647
Germany	8,954
South America	6,892
Russia	5,998
Sweden	4,563
Spain and * Canaries	3,648
* Egypt	3,162
Denmark	3,034
Norway	2,298
Belgium	2,031
Holland	2,018
* Portugal, Azores, and Madeira	1,356
Algeria	1,281
Austria	1,056
Greece	727
Turkey	369
* Gibraltar	354
* Ceylon	239
Rumania	251
* West Africa	233
* Aden	181
British India	179

* Coaling Stations.

The trade returns reveal the fact that those towns which are the outlets of industrial regions have a greater value of exports than imports. Those towns which have no industrial hinterland import more than they export—*e.g.* in 1912 London received 32 per cent. of the total imports, Liverpool 24 per cent., Hull 9.7 per cent., the Bristol Channel 3.8 per cent., the Forth 2.9 per cent., the Clyde 2.6 per cent., the Tyne 1.5 per cent., the Tees .6 per cent. London's chief imports are foodstuffs, largely animal products, manufactured articles, and raw materials, chiefly wool. Liverpool's chief import is raw cotton ; the Humber, foodstuffs and manufactured products ; the Bristol Channel and Swansea, metals ; Cardiff, timber ; and Bristol, foodstuffs.

Liverpool exports 34 per cent. of the total, London 18 per cent., Hull 11.9 per cent., the Clyde 7 per cent., the Bristol Channel 6 per cent., the Tyne 2.4 per cent., the Forth 2.3 per cent. The Bristol Channel and the Tyne are the chief coal-exporting areas, the Tees the chief centre for iron export. Liverpool, London, and Hull export cotton, especially to India, China, and Switzerland. Liverpool exports more woollen goods than Hull, chiefly to Canada. Machinery is the chief article of export from the Clyde and the Forth.

The chief entrepôt ports are London (50 per cent. re-exports), Liverpool (27 per cent.), and Hull (6 per cent.), chiefly in raw materials, wool and cotton for manufacture, grain, oil, seeds, timber, fish, other foodstuffs, and fruit. London controls the tea and coffee trades, while raw sugar is shared between London, the Mersey, and the Clyde.

British Trade Routes.

"Formerly our force of shipping contributed greatly to our trade and safety; now it has become indispensable to our very being."

THE MERCHANT SHIPPING OF THE CHIEF NATIONS, 1886 AND 1912.

Country.	Tonnage, 1886.	Tonnage, 1912.
United Kingdom	9,410,000	18,213,000
Colonies	1,754,000	1,660,000
Holland	419,000	1,129,000
France	1,056,000	2,052,000
Germany	1,410,000	4,628,000
Italy	900,000	1,398,000
Japan	77,000	1,344,000
Norway	1,492,000	2,292,000
* U.S.A.	4,265,000	6,859,000

* Largely engaged on the Great Lakes and in coastwise trade, but not including American-owned ships flying the British flag.

Recent Developments and the Importance of the U.S.A.

The above table ignores the fact that several of the largest lines—*e.g.* the White Star, Leyland, and other lines, totalling over 1,000,000 tons—though flying the British flag and manned by British crews, were owned by the International Mercantile Marine Co. of the U.S.A.; so that, before the war, the U.S.A. owned a very considerable tonnage of ocean-going vessels. In 1915 the American International Corporation (Standard Oil) and the Bethlehem Steel Corporation obtained enormous shipbuilding facilities in the U.S.A., and standardized the whole of the shipbuilding industry, from the making of steel to the making of the standardized parts of steel ships.

In 1917 the U.S.A. entered the war, and immediately commenced building a fleet of 25,000,000 tons. Shipyards began work on American orders at Boston, on the Gulf of Mexico, at Alameda in California, at Shanghai, in Japan, and Harland and Wolff's (White Star) shipyards were retained by America. Considering that the loans made by the U.S.A. to foreign governments amounted to more than £1,400,000,000, it is possible that New York may replace London as the world's commercial capital, if she can obtain the chief part of the world's carrying trade. In 1914 52 per cent. of the world's shipping flew the British flag, while less than 9 per cent. of America's foreign trade was carried in American ships, the U.S.A. shipyards turning out only 200,000 tons of ocean-going ships each year.

The Development of British Shipping.

This dates from the Third Crusade, when a British fleet entered the Mediterranean for the first time. During the twelfth and thirteenth centuries the growth of national prosperity and foreign trade was steady and continuous, till, in the sixteenth century, the mariner-pirate-slavetrader-

buccaneer opened the oceans to British trade. Raleigh complained that Holland had become an international depot of all manner of goods "not one-hundredth part of which were consumed" by the Dutch themselves; "and yet," as he insisted, "the situation of England lieth far better for a storehouse to serve the south-west and the north-east kingdoms than theirs do, and we have the far better means to do it if we apply ourselves to do it." As to fisheries, Raleigh complained that, although the greatest fishery in the world was on the coast of the British Isles, yet Holland sent annually to the four great towns in the Baltic—Königsberg, Elbing, Stettin, and Dantzic—herrings worth £620,000, while England did not send a boatload nor even a single herring up the Rhine to Germany, whose people purchased annually from the Dutch to the value of £400,000. "We send," he continued, "into the eastern kingdoms yearly one hundred ships, and our trade chiefly depends on Elbing, Königsberg, and Dantzic. . . . The shipowners of the Low Countries send thither about three thousand ships, trading with every city and port and town, making their purchases at better rates than we do. . . . The Hollanders send into France, Spain, Portugal, and Italy from the east kingdoms, passing through the Sound yearly with Baltic produce, about two thousand merchant ships, and we have none in that course. They traffic into every city and port around *this* land with five to six hundred ships a year, and we chiefly to three towns in their country: the Dutch trade to every port and town in France, and we only to five or six." The Dutch built a thousand ships yearly, "and yet they have not a tree in the whole country." Soon after, however, came the building of merchant fleets by the great Chartered Companies (*e.g.* the East India Company of 1600 and the Levant Company, 1581). Cromwell's Navigation Law of 1651 and the greater resources of Britain enabled her to rival and finally to triumph over the Dutch and monopolize the carrying trade of the world.

The story of the world's commerce from 1750 is largely

the history of the expansion of the British Empire. The remarkable thing is that private enterprise should have been able to give us the greatest merchant fleet in the world; but it is doubtful whether individual effort, however able, can stand against great organizations financed by their governments, using methods of production less wasteful than ours. At the present time, the U.S.A. have obtained a share of our South American trade, and are shipping coal to European countries where previous to the war we had an absolute monopoly. It is possible that by the scientific organization of shipbuilding and trade, British commerce may once again be the greatest in the world. It is noteworthy that prior to 1914 the Germans and Americans studied the needs of their customers, as well as their languages, weights, measures, and currencies, more than the British did.

Routes and Shipping Lines.

The Far Eastern Route has a main stream of traffic from Antwerp, Hamburg, and British ports to Gibraltar, Alexandria and Suez, Aden, and the great ocean junctions at Colombo, Singapore, Hong Kong, and Yokohama. Colombo is connected by steamship routes with Calcutta, Bombay, Madras, Singapore, and Australia.

The eastward traffic consists of metals, coal, provisions, hardware, and timber to Karachi, with a return trade in wheat, silk, cotton, seeds, and hides; to Bombay, coal, machinery, metals, and textiles; from Bombay, wheat, cotton, oil-seeds, hides, and coffee; to Colombo, sugar, metals, and hardware; from Colombo, tea, rubber, copra, oil, graphite, and spices; to Madras, cotton goods, hardware, and provisions; from Madras, cotton, seeds, coffee, rice, indigo, and sugar; to Calcutta, coal, iron, textiles, hardware, tobacco, and provisions; from Calcutta, jute, cotton, wheat, rice, and tea; to Singapore, piece goods, hardware, and rice; from Singapore, spices, tapioca, rubber, tobacco, tin, and sugar; to Rangoon, iron, hardware,

and provisions; from Rangoon, teak, rice, rubber, petroleum, and cotton; to Batavia, petroleum, coal, iron, hardware, and manufactured goods; from Batavia, sugar, rice, and coffee; to Hong Kong, coal, hardware, sugar, provisions, and manufactured goods; from Hong Kong, silk, tea, tin, rice, and camphor; to Shanghai, cotton goods, metals, and sugar; from Shanghai, tea, cotton, rice, and silk; to Yokohama, cotton and woollen goods, sugar, rice, and wheat; from Yokohama, tea, silk, cotton, flax, and copper; to Manila, textiles and manufactured goods; from Manila, hemp, copra, sugar, and tobacco.

The Pacific trade has developed routes between Australia and New Zealand and South Africa, between Yokohama and Vancouver and San Francisco. Hawaii is the junction for ships crossing between America and Asia, while the Panama Canal brings New York appreciably nearer Sydney and Wellington.

The chief British shipping lines trading with the **Far East** are: (*a*) the *Aberdeen* Line (pre-war tonnage, 74,000), with an outward voyage via Suez to Australia and a return voyage round the Cape—this line had a large emigration traffic; (*b*) the *Anchor* Line (130,000 tons), trading between the Clyde and Bombay, and between Italy and New York—besides its ordinary trade linking India, Glasgow, and New York, it has developed a traffic in pilgrims to Mecca and in European emigrants to the U.S.A., as well as carrying the French and Egyptian mails; (*c*) the *Bibby* Line, trading between Liverpool, London, Marseilles, Egypt, Colombo, and Rangoon; (*d*) the *Blue Funnel* Line (485,000) from Liverpool to Suez, Penang, Singapore, Hong Kong, Shanghai, and London, from Amsterdam to Java and round the Cape to Australia, and from Glasgow, Liverpool, Newport, and Swansea to Manila, Japan, British Columbia, and Seattle; (*e*) the *British India Steam Navigation* Line (557,994), to Calcutta, Singapore, Australia, China, Japan, East Africa, and the Persian Gulf; (*f*) the *Brocklebank* Line, from Glasgow to Calcutta, Italy, and London; (*g*) the *Elder-Dempster* Line (320,000), including the

Dominion Line, having a trade with China, Japan, and between Bristol, Canada, and the Argentine; (*h*) the *Ellerman* Line (558,000), from Glasgow and Liverpool to Colombo, Calcutta, the Mediterranean, and Portugal, also from Antwerp and London to Alexandria and the South African ports; (*i*) the *New Zealand Shipping Company*, trading in frozen meat and New Zealand and Australian produce with South Africa and Plymouth; (*j*) the *Orient* Line (116,000), between Australia and England; (*k*) the *Peninsular and Oriental* Line (540,000), trading with the Mediterranean, India, and China; (*l*) the *Royal Mail and Steam Packet Navigation* Line (1,300,000), which has extended its trade between Southampton, France, Portugal, Colon, the Argentine, and Valparaiso, to China, Japan, South and East Africa, and India; (*m*) the *Shaw, Savill, and Albion* Line (150,000), from Glasgow to New Zealand.

The Southern Routes have a smaller volume of trade, but the South American trade before the war was extremely important. Coaling stations were established at Lisbon, Funchal (Madeira), Las Palmas, Freetown (Sierra Leone), Cape Town and Simon's Bay, and Port Louis (Mauritius), but many of the larger boats are able to make the passage between Cape Town and England without coaling, so that St. Helena is not used as much as formerly. The chief lines trading in southern waters are: (*a*) The *Union Castle* Line (320,000), from Southampton via the Cape to Natal and via Suez to East Africa; (*b*) the *Rennie* Line (33,000), between Liverpool and London and West Africa, Durban, and East Africa; (*c*) the *Booth* Line (103,000), from Liverpool to Havre, Vigo, Lisbon, Madeira, and Para, and from New York to Para, Buenos Aires, Pernambuco, Galveston, and Liverpool; (*d*) the *Houlder* Line (100,000), bringing frozen meat from Argentine to Antwerp, Bristol, London, and Liverpool in return for manufactured goods and coal; (*e*) the *Houston* Line (120,000) also deals in frozen meat from Argentine to Liverpool, New York, and Glasgow; (*f*) the *Lamport and*

Holt Line (200,000), between London, Antwerp, New York, and South America, also deals in rubber and coffee; (*g*) the *Nelson* Line has a passenger and beef trade between London and Argentine.

The North Atlantic Routes have the greatest amount of traffic between the U.S.A. and Europe, sending raw materials, foodstuffs, and manufactured goods to Europe and receiving European goods in exchange. The chief British lines are: (*a*) The *White Star* Line (460,000), between Liverpool, New York, and Canada, from Southampton, Cherbourg, Queenstown, and New York, and from Boston and the Mediterranean; (*b*) the *Cunard* Line (200,000), from Liverpool to New York and Boston, from London and Southampton to Canada, and from Fiume to New York; (*c*) the *Allan* Line (200,000), which carries the Canadian mails, from Glasgow, Liverpool, Londonderry, London, Plymouth, and Havre to Quebec, Montreal, Halifax, St. John, Portland, Boston, and Philadelphia; (*d*) the *Leyland* Line (287,000), from Liverpool to the West Indies, Colon, Galveston, and New Orleans, returning with cotton and trading with Antwerp; (*e*) the *Donaldson* Line (100,000), between Glasgow, Canada, and the U.S.A.; (*f*) the *Wilson* Line (198,000), trading between Hull, New York, Bombay, Rouen, Liverpool, Newcastle, Marseilles, Genoa, Naples, from Manchester to Norway, from Hull to Hamburg, Antwerp, Ghent, and Dunkirk; (*g*) the *General Steam Navigation* Line (60,000), from London and Harwich to Hamburg, Bordeaux, the Mediterranean, Adriatic, Levant, and the Black Sea. Besides these companies the railway companies have steamships trading with and carrying passengers to and from France and the Low Countries.

There is fierce competition in the Atlantic trade—the Americans, Germans, Dutch, and French having considerable fleets engaged in transatlantic trade. French, Italian, Japanese, and American ships are engaged on the Eastern and Southern routes.

British Internal Trade before the War.

Large as our foreign trade was, our internal trade is almost as important. The last available census of production, that of 1907, gave the annual value of our industries as £712,000,000, the annual value of agriculture as £170,000,000, and £12,000,000 as the value of British fisheries. The total value of our imports was £550,000,000 ; of exports, £426,000,000. A balance-sheet would show a profit after all expenses, including a large proportion of the total taxation, were paid, because the value of exports with freightage and capital invested abroad must equal the value of imports. The value of home productions is £894,000,000, that of imports £550,000,000. The excess value of surplus productions, £894,000,000 less £550,000,000, is £344,000,000, which are sold as exports for £426,000,000, giving a profit of £82,000,000 on our trade.

The relative value of the chief British industries is illustrated by the following table :—

	Net Output (in Million £'s).	Number Employed.
(1.) Agriculture	170	2,500,000
Fishing	12	100,000
Food, Drink, Tobacco	90	400,000
(2.) Mines and Quarries	120	970,000
Metals—Iron, etc.	165	1,700,000
(3.) Textiles	94	1,250,000
Clothes	48	760,000
Leather, Canvas, Rubber	9	80,000
(4.) Paper, Printing, etc.	34	330,000
Chemical	22	130,000
Timber	21	240,000
Clay and Stone	17	200,000
(5.) Miscellaneous	54	1,200,000
Total, about	856	9,700,000

The value of the building trade is about £60,500,000 per annum, while public utility services cost £50,000,000. The

iron and steel trades have an output of £153,000,000, compared with £12,000,000 from other metal trades. Agriculture, engineering, and metal-working, the manufacture of textiles, and coal-mining are our staple industries, but the productivity of each industry can be increased by the adoption of labour-saving contrivances and by the adoption of more scientific methods in nearly every industry. It is also necessary to open new markets in relatively undeveloped lands.

"The coal used for power purposes in the United Kingdom is 80 million tons per annum, and this furnishes only about half the power per individual worker which is used in the United States. This tends to encourage industries of lesser production rather than those electro-chemical ones which would give scope for increased skill in many directions. Much coal must in the future be transformed into electrical power, and this conversion should be carried out in large super-plants, each generating 50,000 h.p. or more. There should be sixteen districts for power production under national control, and with such a scheme one-third of our coal would be saved, or we would get greatly increased power (far more than one-third increase). The centres for production should be on important waterways, with good transport facilities, and much space for well-planned works, with towns on suitable sites near but not among the works. The present 600 uneconomical stations of 5,000 average h.p. should be replaced gradually, and in the meantime no more should be created. Attention is drawn to the great success of the experiment in cheap power from coal by a central station scheme on the north-east coast." This summarizes the recommendations of the Coal Conservation Committee of the Ministry of Reconstruction, which, if carried out, should give a great increase in the productivity of our industries, while the further electrification of the railways should avoid the congregation of large masses of the population in slums, besides allowing agriculture to make use of the cheap power and transport which the above scheme would make possible.

The source of power in Britain is coal. The reserve of coal in the principal countries has been estimated as follows (millions of tons) :—

Europe, 784,200.

Germany, 423,360 ; United Kingdom, 190,000 ; Russia, 60,100 ; Austria, 59,269 ; France, 17,600 ; Belgium, 11,000 ; Spain, 8,768 ; Spitzbergen, 8,750.

America, 5,073,000.

U.S.A., 3,226,000 ; Canada, 1,234,000 ; South America, 31,100.

Asia, 1,300,000.

Africa, 58,000.

Australia, 170,300.

From this it is obvious that the U.S.A. will be the greatest industrial nation for a long time if present conditions continue. The U.S.A. produces about 500 million tons of coal per annum, the United Kingdom about 270 million tons, and Germany about 185 million tons each year. The three chief industrial countries are the U.S.A., Germany, and Britain. At present both the U.S.A. and Germany can produce much greater quantities of iron and steel than Britain. It is only by scientific methods that our iron and steel trade can compete in the world's markets with the U.S.A. and Germany.

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APPENDIX.

EXAMINATION QUESTIONS OF THE BRITISH ISLES.

(1.) Mention three important exports from France to the British Isles, and state in what parts of the country each is produced.

(2.) From what parts of the world does the United Kingdom obtain its supplies of (*a*) wheat, (*b*) raw cotton, and (*c*) wool ? Give the chief ports of shipment in each case.

(3.) The watershed of England has been said to have the form of an inverted T. Justify this statement, and mention some of the chief rivers of each of the three slopes.

(4.) From what parts of the world does Great Britain chiefly obtain its supplies of (*a*) dairy produce, (*b*) tin, and (*c*) petroleum ? Mention in each case the port of shipment and the probable port of arrival.

(5.) Write a short account of the system of currents in the Atlantic Ocean.

(6.) Explain fully how the direction of the trade winds is influenced by the earth's rotation.

(7.) State generally the geographical conditions which favour the growth of large modern seaports. Illustrate your answer by examples.

(8.) Describe the form and position of the Pennine Chain, with special reference to the fact that it is not a range of mountains. Explain carefully its relation to the Cheviots and the Lake District.

(9.) The London basin is surrounded by a wall of chalk, except to the east. Draw a sketch map showing the position of this "wall." Name its chief divisions. Show the gaps traversed by the main lines of the Great Western and London and North-western Railways.

(10.) Great Britain produces large quantities of salt. Where is the salt chiefly found, and how is it obtained?

(11.) In some parts of the British Isles the surface consists of limestone or of chalk. State the positions of some of these parts, and point out any peculiar features about the rivers which flow over them.

(12.) Describe fully the course of the border line between England and Scotland. Explain the geographical and historical conditions which determined its position.

(13.) The hours of high and low water at a seaport, and the difference of level between them, vary from day to day. Give a general account of the changes which take place. Can you connect them with the phases of the moon? Explain why there is a difference in the rise and fall of the tides on the same day in the Bristol Channel and the Gulf of Genoa.

(14.) What parts of the west coast of England and Wales have (*a*) the greatest and (*b*) the least annual rainfall? Account for the facts.

(15.) Some towns in England are described as "railway creations." Describe carefully the positions of two such towns, and state the geographical conditions which account for the growth of each.

(16.) Compare the counties of Argyll, Caithness, and Norfolk, with regard to race, language, and occupations. Add short historical or geographical notes according to the facts.

(17.) Draw a sketch map showing the North Channel between Scotland and Ireland. Show Belfast Lough, Strangford Lough, Loch Ryan, and the Kintyre peninsula. Mark the towns Larne, Ayr, Campbeltown, Stranraer, and Belfast.

(18.) Describe the positions of the two chief districts in England which produce iron ore. Compare the two districts as

regards (*a*) supplies of coal for smelting, and (*b*) the most important manufactures carried on. Name the most important town in each.

(19.) The weather forecast for the London district on a certain date was: "Strong south-easterly gales, veering to north-west and moderating later." State and explain the chief facts which would justify this forecast.

(20.) It has been proposed to construct a ship canal connecting the Firth of Forth with the Firth of Clyde, making use of Loch Lomond. Trace the course of the Forth on a sketch map, showing the outlines and relative positions of the two firths and Loch Lomond. Mark Loch Long, the island of Arran, Leith, Grangemouth, Glasgow, Rosyth, Greenock, Alexandria, the Forth Bridge, and show the probable course of the canal.

(21.) Wool was at one time the most valuable commercial product of Britain. State where the wool was chiefly produced, and describe the conditions specially favourable to it. Compare the conditions in Britain with those of the wool-producing region of Australia.

(22.) Compare the geographical conditions affecting the formation of counties south of the Thames and Severn with those of the Midlands.

(23.) What are the chief types of coast found in Great Britain? Give a short description of each type, and indicate a part of the coast where it occurs.

(24.) Compare the general distribution of population in Scotland and Ireland. Account for the differences you point out.

(25.) The average size of ocean-going ships has greatly increased during recent years. Discuss fully, with examples, the effect of this on the size and position of modern seaports.

(26.) Describe (*a*) the physical features, (*b*) the climate, and (*c*) the soil of Devon and of Lincolnshire. Name the characteristic products and industries of each of these counties, and show how they are determined by the physical features.

(27.) Name and describe the planetary winds in the north-

ern hemisphere. What are the causes that modify the planetary circulation in Western Europe? What modifications occur in (*a*) July and in (*b*) January? How do you account for (*a*) a strong westerly gale in the English Channel, and (*b*) a dry east wind in Norfolk? At what times are these most likely to occur?

(28.) What is the chief industry in each of the following towns: Bradford, Grimbsy, Stoke-on-Trent, Manchester, Middlesbrough, Southampton? Select three of the towns and account for the industry prevalent in each.

(29.) What are the chief factors which determine (*a*) the winter temperature of the British Isles; (*b*) the rainfall of South-eastern Europe?

(30.) Draw sketch maps of either (*a*) the Severn estuary, showing the rivers Wye, Parret, Avon, Usk, with the Mendip Hills and Brecon Mountains, or (*b*) the Firths of Forth and Tay, showing the Ochil Hills, Pentland Hills, Lammermuir Hills, Sidlaw Hills, Stirling, and Strathmore. Give an account of the trade of either Cardiff and Bristol or Leith and Dundee.

(31.) Describe the main physical features of Yorkshire and of Gloucester, and give the exact position of two important towns in each. Account for the great growth of manufacturing industries in Yorkshire.

(32.) Indicate and account for the position of warm and cold currents in the North Atlantic Ocean. What is meant by the Continental Shelf? Describe its outline from Norway to Spain. On what parts of the Atlantic are the most valuable fisheries?

(33.) Describe the river systems of North Wales and South Wales. Show how the geographical features of Wales have influenced (*a*) its past history, and (*b*) the present population.

(34.) Give an account of the distribution of population in Wales. Give reasons for the facts you mention.

(35.) The average temperature in January at Cape Wrath is approximately the same as that of the Isle of Wight, whereas in July it is 7 degrees lower. Account as fully as you can

for these facts. In what parts of the British Isles are the most extreme and most equable climates to be found?

(36.) Describe some of the characteristic features of manufacturing industries in mountainous districts. Illustrate your answer by examples.

(37.) A number of seaports in the British Isles are used as calling-places by ocean-going mail steamers. Name and describe the positions of two such ports, and explain fully why they are so used. Describe the routes connecting the ports you name with London.

(38.) State and explain some of the ways in which the position of Great Britain has helped the growth of her manufacturing industries.

(39.) Draw a sketch map of South-eastern England to show the North and South Downs and the Weald. Insert as many rivers as you can, and mark carefully where they flow through "gaps" in the Downs.

(40.) Give an example of a district where there are many fairly large towns situated close together. Mention some of the geographical causes which have brought about this in the district you mention.

(41.) Describe carefully the positions of the chief naval stations in England. Mention any geographical conditions which have determined their situation.

(42.) Write a short account of the Southern Uplands of Scotland, describing the general nature of the surface. What are the principal rivers draining them, and into what seas do they flow? What are the principal occupations of the inhabitants?

(43.) Describe the country passed through by one of the main railway routes from London to Plymouth.

(44.) State the conditions which have given special importance to Belfast, Carlisle, Gloucester, Newcastle, and Portsmouth, either in the present or in the past.

(45.) Describe the configuration of the land in the south-east corner of England between the Thames and the English

Channel, limiting your answer to the counties of Surrey, Kent, and Sussex, and point out clearly the natural routes from London to Dover, Hastings, and Brighton.

(46.) What geographical conditions give a town commercial importance? Illustrate from the British Isles.

(47.) The ports on the east coast of Ireland are far more important than those of the west, although the latter possesses better natural harbours. Account for this, and name two ports on each coast which illustrate your explanation. Describe their positions and give an account of their trade.

(48.) Explain the historical importance of the Cheviot Hills, the estuary of the Humber, and Gloucester.

(49.) Mention five towns once important that have now declined, and point out the geographical reasons for their fall.

(50.) Describe the positions of the Scottish coalfields, and give an account of the industries which have sprung up round each of them.

(51.) Explain the meaning of the term "hinterland." Give an example of a hinterland. Name and describe the position of its chief outlet, and give an account of its trade.

(52.) Describe the position of the Black Country. Between what river systems is it enclosed? Illustrate your answer by a sketch map. Mark on this map the chief town of the district, and describe and account for its trade.

(53.) State the name and describe the position of an English port at which you could embark on a journey (*a*) to Paris, (*b*) to Holland, and (*c*) to the Channel Islands. Describe in detail the English portion of the journey.

(54.) Write a short account of the Caledonian Canal, and compare its importance with that of the suggested ship canal connecting the Firths of Forth and Clyde.

(55.) State fully why Irish time is twenty minutes slower than English time.

(56.) Name and describe the positions of (*a*) one important Government dockyard, and (*b*) two ports in the United Kingdom where large ships are built by private firms. What are

the special facilities for shipbuilding at each of the places which you select ?

(57.) Either (*a*) draw a sketch map of the six northern counties of England to show the positions of the chief hills and rivers, marking Leeds, Carlisle, Preston, Sheffield, and Manchester, or (*b*) compare the central plain of Scotland with that of Ireland and the chief occupations of the people in each.

(58.) Describe fully the positions of six ports passed on a southward voyage from Dundee to Plymouth. Say what you know of the shipping trade of any two of these ports.

(59.) Name five of the largest towns on or close to the east coast of Scotland. State the principal industries of each, and give reasons for the presence of these industries.

(60.) Where is the Plain of York ? How is it bounded ? Describe its river system. What main lines of railway cross it ? Name its chief industries, and account for their importance.

(61.) You are contemplating visits to the following: Killiecrankie, Killarney, the Norfolk Broads, and Sark. How would you reach each of them from London ? Describe in some detail what you would expect to see if you actually visited any two of them. Mention in each case the season of your visit.

(62.) Compare (*a*) the summer and winter daylight periods of the Shetlands and the Isle of Wight ; (*b*) the export trade of Cork with that of Milford Haven ; (*c*) the agricultural products of Kent with those of the coastal strips of Forfar and Fife.

(63.) Enumerate the circumstances which have led to the development of the seaports of the north of England.

(64.) Taking the counties of Essex and Somerset, or of Antrim and Ayr, show what different effects situation and physical features have on industrial progress.

(65.) Describe the courses of the chief Roman roads in England.

(66.) Indicate the most important steamer routes between England and Ireland. Estimate the importance of each route.

(67.) Give an account, with diagrams, of the London basin.

Explain how in some cases London obtains water from artesian wells.

(68.) Discuss the economic value of rivers to man, and show how their natural conditions may be improved. Give examples in support of each point in your answer.

(69.) What are the most important classes of goods constituting respectively the imports and exports of Britain? State carefully the causes of specified classes being important in the import trade and unimportant in the export trade, and *vice versa.*

(70.) Describe a great railway route from London to Manchester, giving the characteristics of land surface, rivers, nature of scenery traversed, most important towns passed, and leading industries of the districts served by the line. Account for any differences of climate.

(71.) To what geographical conditions do the following owe their prosperity: Cork, Glasgow, London, Manchester?

(72.) Give accurately the position and describe the importance of the Dogger Bank, the Fens, the Humber, the Potteries, the Rhondda Valley, Liverpool, Barrow, and Bradford.

(73.) Comment on the following: (*a*) Compared with Denmark, Britain is in a disgraceful condition with regard to the supply of milk; (*b*) generally speaking, mountains encourage a love of home and the military spirit, while seas encourage love of home and the commercial spirit; (*c*) a factor in the choice of a site for a city was its capability for defence.

(74.) From your knowledge of the history of the following towns show how and why they have varied in geographical importance: Norwich, Bristol, Coventry, Carnarvon, Barry, Builth, Perth, Inverness, Glasgow.

(75.) Mention three or four counties in England and Wales in which you would expect to find (*a*) the greatest number of cattle per thousand acres; (*b*) the greatest annual rainfall; (*c*) the greatest proportion of miners. State carefully the considerations which determine your choice.

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